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Some of the difficulties that the engineers had to contend with at Mile 9

Working on a bend in the road at Mile 10

Building the World's Highest Highway

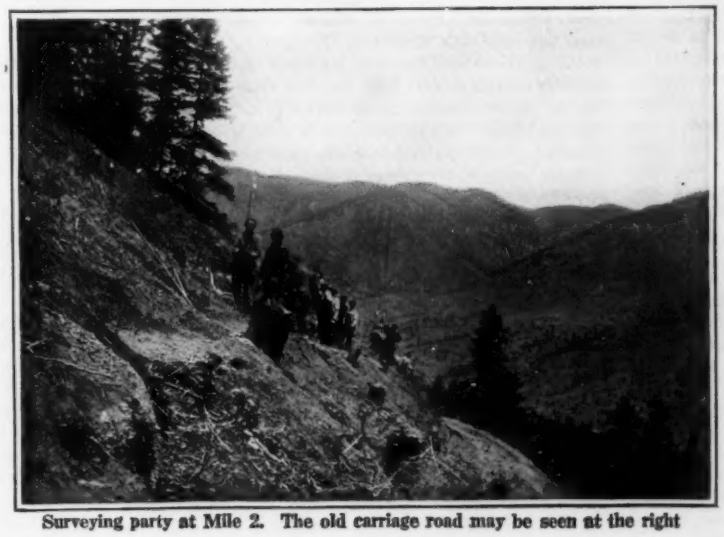
By N. L. Drew

FIVE score and ten years ago Lieut. Zebulon Montgomery Pike discovered the famous mountain that now bears his name. After making several attempts to reach the summit on foot he was forced to give up, predicting in his diary that no human being would ever be able to scale its rocky heights. For thirteen years thereafter the great white mountain hurled defiance at many other sturdy pioneers who made similar attempts to reach the top. In August of 1916 the speed kings of the motor world are going to race up the rock-walled sides of this giant sentinel of the Rockies over a double track motor highway that has been pronounced by eminent engineers to be one of the greatest road building achievements of the age.

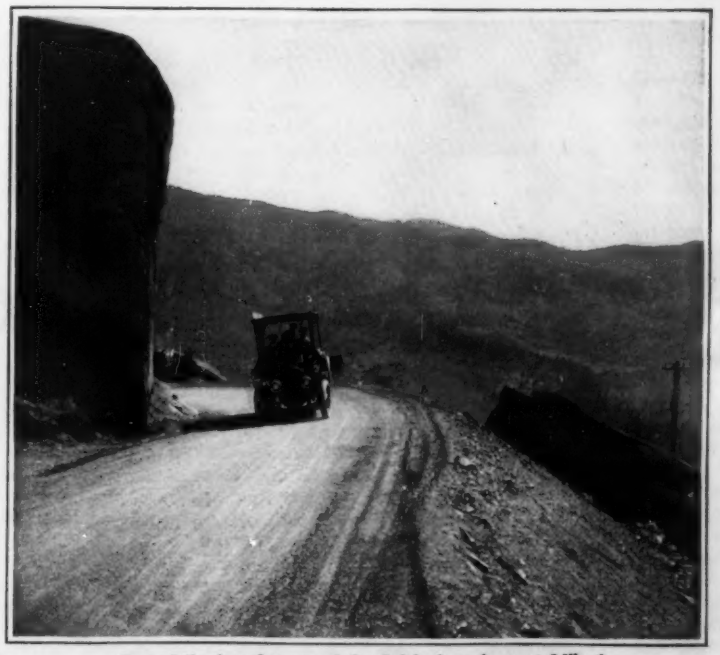
To scale this mighty mountain with a 20-foot highway, 18 miles long and reaching into the clouds 14,109 feet above the sea, required engineering skill, push, dynamite, men and money. Government engineers had predicted that it could not be accomplished in two years, but the builder did it in five months between the snows of 1915.

Early in January of last year, Eugene A. Sunderlin, of Colorado Springs, secured pledges of financial support, and in May he began construction of the world's highest highway to the summit of Pike's Peak. Large construction camps were established every second mile. Expert rock workers were brought in from the mining districts; and with fifteen 20-ton cars of dynamite, the road was blasted through fields of massive boulders and up the precipitous granite walls of the Peak. From sun to sun for five months a ceaseless roar of tons of explosives was re-echoed by the grim old mountain to the valleys below. Great boulders were lifted from their anchorage and thrown down the mountain sides 2,000 feet below. Giant pines were lifted up by the roots with powder to make way for the road.

Specifications called for a minimum width of 20 feet, on tangents with curves from 26 to 50 feet as required and superelevated, so that two machines might pass at any point with safety. The grade has been held to an average of 6 per cent, with a maximum of 10 per cent, which will permit any car to negotiate the summit with ease. Masonry parapets, 2½ feet high and 18 inches wide, for guard rail walls on curves which average 40 degrees, are provided where needed. Gravity or windmill tank and hose water stations are spaced every third mile, together with supply and repair stations at convenient points. Telephone stations afford easy communication with the outside world. The five bridges are of reinforced concrete of the ballasted deck type and are located on tangents only, and may be seen 300 feet away. The surface of the road is all of a disintegrated granite formation, which has been packed down by the use of wide-tired trucks to a hard and smooth surface.



Surveying party at Mile 2. The old carriage road may be seen at the right



One of the broad turns of the finished roadway at Mile 2

Starting at Cascade in Ute Pass, 12 miles west of Colorado Springs, the first two miles is one large swing in order to gain elevation and enter Cascade Cañon, half a mile above the starting point. Miles 3, 4 and 5 follow the water grade of Cascade Creek to the divide between this and Crystal Creek watershed, and then cross the latter stream in Mile 6 by a slight adverse grade. The next five miles is a climb to the base of the main range of the Peak, at Glen Cove, a beautiful natural amphitheater near timberline in Mile 11. Leaving Glen Cove, the ascent to the crest of the Rampart Range in Mile 14 is made by a series of ten immense swings of the road forming two "W's," two swings preceding and two following. In these three miles over 60,000 cubic yards of solid rock were excavated, but it was practically the only route over which the top of the range could be gained; for on all other routes proposed there is a sloping country with angles of repose which did not afford safe or permanent road-bed sections. Miles 15 to 17 follow along the backbone of the main range, the last mile having three swings by which the summit is gained. Here are several acres of comparatively level space for parking purposes.

A trip over this magnificent highway offers much of scenic interest to the motorist and may be made easily in two hours in each direction.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Arms and the Man

IN its broadest generalization, it may be said that an army is made up of personnel and supplies. Each is fully as important as the other. Arms without the man would be only less impotent than the man without arms. The immortal Bryan's army of 1,000,000 men, raised between sun and sun, would be merely a mob 1,000,000 strong.

In its legislative work for a larger army Congress seems to be overlooking the equally important matter of providing (as it should do simultaneously) the corresponding supplies of guns, ammunition, transport and general equipment.

The Russian disaster of last year showed the helplessness of a large army insufficiently equipped, when confronted by a force well supplied. An examination of the hearings of our staff officers before the Congressional committees this year proves that we are far behind Russia in supplies of all kinds.

We have none of the large field pieces which have proven so valuable in the European War. Our largest field piece is the 6-inch, which the English artillerists call "The Baby." The total of our field guns is 900 of all calibers, sufficient for an army of 250,000, without any reserve. Of ammunition there is less than 650 rounds per gun. It is reported that, in certain actions, the French artillery has fired 1,000 rounds per piece. Our arsenals are capable of producing about 500 field guns and about 500,000 rounds of ammunition per year; the latter General Crozier estimates as being about one fiftieth the amount used by one of the countries now at war.

In rifles the situation is equally serious. We have 700,000 service rifles and about 400,000 of the old Krags. The maximum output of our arsenals is 437,000 rifles per year, working day and night. Of ammunition we have a reserve of 300 rounds per rifle, and our plants, also working three shifts, could turn out something over 300 rounds per rifle per year. When it is considered that each soldier carries 120 rounds for one day's engagement the inadequacy is easily appreciated.

The Chief of Ordnance reports that we have 1,077 machine guns completed and under manufacture, "not all, by any means, of the latest model." For the present army alone 2,225 are needed, and this is based, not on lessons learned from the great war, but on theory prior thereto.

Of personal equipments of the soldier we have on hand only 450,000.

Our coast forts are armed largely with obsolescent guns and mortars, excellent when designed and mounted, but now far behind naval ordnance in range and power. Some of the carriages can be remodeled to give the guns greater range, but new and more powerful weapons are a vital need in all of the more important harbors, if an enemy is to be held beyond bombarding range of the cities our forts were constructed to protect. For the guns we have, the ammunition is notoriously insufficient —a half hour's continuous fighting would see the end of it in most batteries. We hear also of shortage in searchlights, in range-finding apparatus, in submarine mine material and in air craft. The Chief of Coast Artillery dwells upon these in his annual report.

Consideration of the foregoing should indicate the fallacy of depending upon government-owned plants for the supply of munitions of war. In all these years of peace they have been able to supply only our small army, and accumulate a reserve sufficient for a quarter of a million men for a war lasting from a few days to a month according to the energy with which we were attacked. The European War has demonstrated that all resources of a nation must be mobilized for modern war. Numerous private ammunition plants have been started in this country. It seems the part of wisdom to conserve this resource. The owners cannot be expected to continue operations if the demand ceases. Our Government should not permit the demand to cease until we have accumulated a sufficient reserve, and then the companies should be paid a reasonable amount annually to maintain the machinery in condition and to keep a nucleus of trained personnel.

And we should not await the preparation of designs for large-caliber field guns. Several of the warring countries have guns of proven effectiveness. Why not make weapons of the same types until something better is found? We should then, at least, start even, instead of many years behind.

We have felt secure in the matter of transport on account of our great motor car factories. But in spite of the Quartermaster General's testimony of our "organized motor truck companies" (tentative), a week elapsed before General Pershing could start his pursuit of Villa with 4,000 men. Neither trucks nor chauffeurs were available. Villa, instead of being overtaken in a day, had a week's start, involving us in a prolonged campaign of doubtful result, and in a diplomatic situation which will require the nicest handling if worse is to be avoided. So much for paper organizations. In reality the Army is short even of the obsolete wagon transportation, and the Militia is generally without draft animals of any kind.

General Aleshire states that we have reserves of clothing for 150,000 men, and that in 90 days we should be able to turn out uniforms for 600,000 more. It is true we have not the dye for these new uniforms, any more than we have the nitrates to continue the manufacture of powder for more than a month; but these things do not seem to cause any worry to those responsible for the conditions.

Further examples seem unnecessary. *The situation may be summed up by the statement that in practically every essential we are short of proper reserves for our existing military forces, to say nothing of those we propose to create.*

Our legislators shrink from the thought of a bond issue. But how otherwise are we to remedy promptly the results of our niggardly past policy, in which each Congress, under guise of economy, has declined to appropriate sums sufficient for our needs? The current revenues will not meet the issue. Our modest field artillery project would cost $280,000,000 for guns alone; the half hour's allowance of coast artillery ammunition has cost over $7,000,000. To modernize our coast forts and emplace guns of sufficient power to repel modern warships will cost not less than $100,000,000. If the proper equipment of our new army, with the National Guard second line, can be done with less than a billion, it will be surprising.

It is an issue we cannot dodge. If even the poorer nations of Europe are willing to meet the needs for defense (or aggression) are we with all our wealth, estimated by the Bureau of Statistics to be $225,000,000,000, with all we have to protect, to hang back? If we are, let us at least do it with our eyes open. Let us know that we are maintaining an expensive military force without giving it the equipment which alone can make it an effective protection to the nation.

Zeppelins as Battleship Destroyers

EVER since the beginning of the European conflict, much has been said regarding the use of Zeppelins in naval engagements. The recent dispatch from a correspondent of one of the American press associations, to the effect that the Teutons have been experimenting over Lake Constance with a highly destructive form of bomb suspended on a two-mile cable, again directs our attention momentarily to these mighty airships.

It is safe to assume that Count Zeppelin, in designing his airships, has not only had in mind their employment in land operations, but also in naval engagements; furthermore, we are tempted to believe that the aged inventor has for years cherished the hope of some day seeing his air cruisers, equipped with terrible and heretofore unknown engines of warfare, capable of swinging the tide of naval supremacy from Great Britain to the side of Germany. This much we know: experiments with bombs and aerial torpedoes have been carried out at the Zeppelin plants with a persistency of effort that is characteristically Teuton.

During the naval engagement in the Bight of Heligoland the British cruisers found themselves in combat not only with enemy vessels and submarines, but also with German seaplanes and Zeppelins. It will be recalled that during the engagement the air cruisers dropped a number of bombs intended for the destruction of the warships; but owing to the difficulty of aiming and the skillful maneuvering of the British vessels, these failed to reach their mark. This engagement, then, proved more or less conclusively that aerial bombs may be readily evaded by vessels in the hands of skilled crews, and that the possibilities of the bomb droppers scoring hits on their targets below are no greater—if as great—than those of the anti-aircraft gunners hitting their aerial antagonists.

It would be premature to state definitely that the Teutons have been discouraged in the use of aerial bombs, for legitimate military and naval attack. They are not a people to be readily discouraged in the development of an idea. Better be it said that they have latterly turned their efforts in other directions in the endeavor to obtain more certain results, among these being contact mines and bombs lowered down from the Zeppelins by means of fine steel wires.

The present rumor conveys the information that the Zeppelins of the most recent type are equipped with bombs filled with powerful explosive, suspended by a wire cable a mile or two below the airship. It is reported that the bombs are exploded electrically by the Zeppelin crew the moment they come in contact with an enemy vessel. At a first reading this new engine of warfare, if it were practicable, would be truly formidable; but let us analyze the problem confronting the use of such bombs. Let us assume that the explosive rests on the surface of the water, and is dragged along by the cable, until it comes in contact with enemy vessels. Anyone who has had experience in towing will realize how impossible it would be to direct, with any accuracy, the movements of a floating body drawn over the surface by a towline some 2 miles in length. A change of course by the Zeppelin would not be communicated to the floating bombs for several seconds, and at first only to a very limited degree. The process would be so slow that a slight change of helm would put the vessel attacked out of the danger zone. Meanwhile he would turn his rapid-fire battery upon the bombs. Indeed, torpedo boat destroyers and smaller craft might well be employed to circle about the major units of a fleet, just as they do in present practice as a precaution against torpedoes. There is a possibility that the bombs are intended to be lowered directly over the targets; but this brings up the old question of marksmanship and of maneuvering by the enemy vessel, so that little is gained over the use of ordinary bombs.

It is safe to brand this latest rumor as another of the almost countless ones that have preceded it, most of which are circulated more for their moral effect on the enemy's and neutral world's citizenry than as advance information for the benefit of the fighting men who oppose the Teutons and their allies.

Government Manufacturing

THE present hearing in the Senate Committee of Naval Affairs on the question of the establishment of a government armor making plant is bringing up all the elements of the general question of the extent to which the Federal Government should go in the manufacture of materials required for its own consumption. The materials used by the Government cover the entire field of industry and consist in part of special products for which national governments are almost the only market, such as armor, artillery, warships, munitions, etc., and in part of materials of general use.

At the present time the Government is engaged in considerable manufacturing activity in both categories, and some of its enterprises have produced very beneficial results, such as the reduction in the cost and the increase of the supply of powder, the reduction in the time required to build battleships, the increase in the supply and capacity to supply torpedoes and mines.

The amount of manufacturing to be undertaken by the Government should be determined by business principles and military necessity. The present war has shown the necessity of supplementing the country's capacity of production of a given article of restricted use in peace times, to make sure of the provision of adequate amounts during the unusual demands of warfare. It may be necessary to stimulate competition, where, because of restricted demand, insufficient interest is taken by private enterprise in producing the article on time and with economy. Furthermore, government manufacture may be required to prevent excessive prices or to determine proper prices where they are believed to be excessive.

Most of these considerations, of course, do not obtain for articles in general use, where quantities are sufficient and prices established by a large volume of trade. Hence, in order to proceed intelligently, the unsatisfactory condition that exists should be carefully defined in order that the manufacturing undertaken by the Government should correct, regulate and stimulate it, without providing for the entire capacity required.

The first step should be to take census (as is now being done by the Naval Consulting Board) and then develop the munition-making capacity of this country to take care of the maximum probable expenditure during war, the Government to supply manufacturing capacity which cannot otherwise be obtained.

The ability of private enterprise to expand to any emergency when called upon, if it has a certainty of sufficient business, is at the present time. Much can be obtained by appealing to the patriotism and business sense of the industries affected, and further extension of Government manufacturing should await the result of that appeal.

Electricity

An Electrical Apartment House for New York.—It is learned that plans have been drawn up for a model sixteen-story apartment house soon to be erected in New York City, in which electricity will be used in every possible way, including cooking and refrigeration.

Tungsten Consumed in Lamp Manufacture.—It is gathered from unquestionable authority that the total amount of standard tungsten ore used in the manufacture of incandescent lamps in the United States in 1915 was in the neighborhood of 4½ tons.

The Stealing of Rail Bonds.—Among the problems of a Massachusetts street railway company is that of preventing its rail bonds from being stolen. Recently about 170 copper rail bonds were removed from its tracks with a chisel and sledge hammer, representing a loss to the company of some $300 for material alone, not counting the inconvenience caused to traffic and the cost of labor in re-bonding the rails.

Metal-Vapor Lamp Invented by Nernst.—Prof. Nernst, inventor of the Nernst lamp, has patented a new vapor lamp in which the vapor from zinc chloride or zinc bromide is used, according to a statement in *Elektricität*. It is said that the color of the light is white and that the efficiency is in the neighborhood of that of the mercury-vapor lamp. The exclusion of air and other foreign gases is essential to the successful operation of the lamp.

Electric Radiators for Electric Vehicles.—A domestic manufacturer has introduced an electric heater intended for use in electric vehicles. In general appearance the heater resembles a steam radiator; it is made of cast iron sections 15 inches high and has 3 square feet of radiating surface. An insulating liquid is placed in the coils of the heater, while the heating element is mounted in the bottom. The latter operates on 80 volts and requires a current of about 3.9 amperes for furnishing a temperature of 190 deg.

Load Dispatching Record on Phonograph Cylinder.—A Pennsylvania power company has installed phonograph dictating machines at the main power plant and at a substation, which serve to make a wax cylinder record of all telephone messages regarding load dispatching. All messages which are received are repeated to the sender, so that corrections if necessary can be immediately made in the orders. The two phonographs act as a check on each other and avoid all disputes.

Lineman's Shoe Withstands 20,000 Volts.—An American manufacturer has recently placed on the market a line of shoes for electrical workers, which are made to withstand potentials up to 20,000 volts without harm to the wearer. The shoes contain no cement and have no seams, but are vulcanized into a solid piece under high pressure in aluminum moulds. A novel feature of the shoes is that the soles are white, and under the white surface is a layer of red rubber. When the sole has worn down to a point where the red is exposed, it is a sign to the wearer that a new half sole should be immediately cemented in place.

Gas-Filled Lamps in Photographic Work.—The convenience and comparatively low cost of gas-filled electric lamps has resulted in their wide adoption in photographic work. Usually the lamps are operated at a 10 per cent increase in voltage in order to augment materially the actinic value of the light emitted by them. Obviously, the life of the lamps is reduced by this practice, but since the lamps are only used for very short intervals at a time, the reduction in life is negligible. It is stated that the lamps, operating at a 10 per cent increase in voltage, have a life of about 300 hours instead of 1,000.

Power Company Substitutes Copper for Aluminum.—Owing to the abnormal price of aluminum at present, a California power company recently took down cables of that metal serving in some 22 miles of transmission lines and replaced them with copper ones of greater carrying capacity. The proceeds from the aluminum wire thus released from service are said to have been sufficient not only to pay for the copper cables but also for the labor involved in making the change. It is reported that the company is continuing in this work and that several other power interests are doing likewise.

Electric Heat for Shoe Machines.—In the shoe factories of Lynn and Brockton, Mass., there is being witnessed the gradual introduction of welting machines, shoe stitchers and bobbin winders equipped with electrically-heated wax pots. Heretofore, steam-operated machines were used. It is interesting by way of contrast to learn that in some shops it requires an hour and a half to bring the wax to the proper point for application, while electrically-heated wax pots bring their contents to the desired point in only 20 minutes. This difference in time results in a considerable saving when electricity is used; the current is reported to cost but 20 per cent as much as gas to do the same work.

Science

A Notable Gift to the University of California is the library of about 6,000 volumes representing France's contribution to civilization, which formed part of the French government exhibit at the Panama-Pacific Exposition.

Varieties of Maize Grown by the Indians.—The Bureau of Plant Industry has been investigating the maize grown by various tribes of American Indians, with a view to obtaining breeding material for the improvement of commercial strains. Thirty varieties have been studied, and it appears that they include many adaptations, the value of which had been previously overlooked. The Assiniboine and Mandan tribes have both sweet and field varieties that are earlier than the commercial varieties. Others, particularly the Omaha and Otoe tribes, have varieties showing a remarkable development of slender, leafy stalks suitable for forage.

The Tuatara, or tuatera, is an almost extinct lizard-like reptile (*Sphenodon punctatum*), now found only on certain rocky islets in the Bay of Plenty, northern New Zealand. It is of great scientific interest for the reason that it is the only surviving representative of the order of Prosauria, or primitive reptiles, and is therefore a sort of "living fossil." It was formerly hunted for food, but is now protected by law in New Zealand. The *American Museum Journal*, in which the foregoing facts are recorded, stated that of five living specimens of this reptile which formed part of the New Zealand exhibit at the Panama-Pacific Expositon, two have been presented to the American Museum of Natural History. No living specimens had been seen in this country prior to the exposition.

Some Details of Otto Sverdrup's Expedition along the Siberian coast, which returned to Archangel last September, are published in the *Geographische Zeitschrift*. The expedition wintered on the east side of Cape Wild, whence a sledging party was sent to join the Vilkitskii expedition, which was frozen in on the east side of the Taimyr peninsula, about 200 miles distant. As Vilkitskii's party was running short of food, thirty of his men marched across the peninsula and joined Sverdrup's ship. A thorough exploration was made of Lonely Island, discovered by Johannsen in 1878 and never since revisited. It was found to contain rich coal deposits. Many corrections were made in the map of the coast between Cape Chelyuskin and the Yenisei River.

Topographic Mapping and National Defense.—The *Geographical Review*, in commenting on the work of the U. S. Geological Survey, makes the interesting point that the relatively slow progress of topographic surveying and mapping in this country is serious from a military point of view. "Maps covering 40,000 square miles are less showy than a battleship, but they may be of much greater importance in time of war." Only 40.2 per cent of the area of the country has been covered by topographic surveys up to the end of the last fiscal year. The area mapped during the year was 20,508 square miles. Mapping has been completed for Connecticut, the District of Columbia, Maryland, Massachusetts, New Jersey, Rhode Island and Washington. New York State is 89 per cent complete and Ohio 97 per cent.

A Fog-Signal Sound Deflector.—The nerve-racking noise of a fog siren is a problem that needs to be dealt with whenever one of these valuable devices is located near human habitations. The Bureau of Lighthouses has recently installed a sound deflector at the Buffalo light station, to diminish the spreading of the sound from the fog signal back over the city of Buffalo. It consists of a saucer-shaped shield of steel plating, 14 feet in diameter. In order to reduce vibration, it is lined on the face toward the lake with asbestos board, and, to further deaden the sound, a space of 4 inches between the asbestos lining and the steel is filled with mineral wool. The steel surface was suitably treated to minimize or prevent corrosion from the sulphur impurities in the wool. The deflector is reported to be effective in reducing the sound of the siren in the city.

Fog Statistics of the Lighthouse Bureau.—The *Lighthouse Service Bulletin* publishes a compilation of the number of hours of fog or thick weather observed per year at 508 fog-signal stations during the period 1885 to 1915. As such stations are maintained in all coastal regions of the country, including the Great Lakes, which are subject to fog, their records are a valuable indication of the extent of this danger to navigation. The highest annual average is 1,691 hours a year at Petit Manan, Me., while the highest record for an individual year and place is 2,734 hours in 1907 at Seguin, Me., or about 30 per cent of the entire year. It is interesting to learn that Calumet Harbor, near Chicago, had 2,269 hours of fog in 1913. This and other lake stations are affected somewhat by smoke. On the Pacific coast the highest annual average is 1,337 hours at Point Reyes, but in the year 1915 there were 2,145 hours of fog at San Francisco Light.

Industrial Efficiency

Reference Books and Modern Business.—There is a growing tendency in modern business to make the utmost use of reference books and authoritative publications. This attitude is not only reflected by the management of large organizations, but even among the men themselves, who look forward to books and periodicals to aid them in their work. Many of the more progressive manufacturing firms have already installed reference libraries in charge of skilled librarians for the use of their staff.

Counting by Weighing.—No longer is it considered good management to count uniform pieces one by one in manufacturing plants. Scales especially constructed for the purpose are now being employed for counting material of like units. Not only is the weighing machine more accurate because it substitutes simple manual operation and the highest degree of mechanical precision for the complicated mental figuring and inaccuracies of other systems, but it counts from 100 to 1,000 per cent faster than the timeworn methods.

Training College Men for Foreign Trade.—It is reported that a newly formed fifty-million-dollar corporation, which has for its main object the promotion of foreign trade, purposes to employ a large number of young men and to educate them for permanent positions in the foreign field. Most of the young men will be selected from college graduates. If the proposed plan is realized in the future, it will undoubtedly be one of the most important and vital steps yet taken by American business men to secure—and hold—foreign trade.

Physical Examination of Employees.—Arrangements have been made by a Philadelphia gas company and a number of its interests to offer free physical examinations to the employees. It is claimed by the company that these examinations will reveal conditions that have not developed sufficiently to interfere with comfort and usefulness yet which, if neglected, would be serious. Not a few concerns have already inaugurated the same service and have proved the desirability of the arrangement and its economic value to both employer and employee.

One-Man Street Cars in the Ascendency.—Several cities in the United States are now using one-man street cars with the result that the operating expenses are considerably reduced. Double-end cars are remodeled for one-man operation by inclosing the platforms, and providing door-operating mechanisms and fare boxes. Passengers enter the car at the front end, where a single employee acts in the capacities of conductor and motorman. It is reported, however, that ordinances have been enacted in various cities and states prohibiting the operation of one-man street cars.

Solving the Paper Shortage.—The attention of the Department of Commerce has recently been directed to the fact that there is a serious shortage of raw material for the manufacture of paper, including rags and old papers, by the president of a large paper manufacturing company. He urges that the Department make it known that the collecting and saving of rags and old papers would greatly better existing conditions for American paper manufacturers. Something like 15,000 tons of different kinds of paper and paper board are manufactured every day in the United States, and a large proportion of this, after it has served its purpose, could be used over again in some class of paper. A large part of it, however, is either burned or otherwise wasted—another instance of our national inefficiency.

Eliminating the Postage Stamp.—There has lately been placed in service by several American firms with unusually heavy mailings a postage meter which, instead of affixing the usual postage stamps on mail matter, makes an impression in the upper right-hand corner. The new postal meter performs several tasks, such as sealing, stamping, facing and counting approximately 250 pieces of mail matter per minute. The envelopes, unsealed and unstamped, are placed in a compartment of the machine much in the same manner as they would be placed in a box, the mechanism handling the envelopes automatically from that point. The stamping mechanism not only makes an impression on the envelopes, but also counts, the numbers appearing in a descending serial on top of the stamping meter. The meter is so made that its mechanism can only be adjusted by the post office authorities, who set it for the number of impressions the user has paid for. When that number of impressions is exhausted, the meter automatically locks and no longer stamps mail matter, necessitating its return to the post office for readjustment. The elimination of loss through fire or theft, the reduction of handling costs both in the matter's establishment and in the post office, and the expediting of outgoing mail are but a few of the advantages this system offers over the adhesive stamp method. The impressions are not canceled.

The Extreme Ranges of Modern Guns

A Study of the Theoretical as Distinguished from the Useful Ranges of Modern Artillery

By Alston Hamilton, Major Coast Artillery Corps

RECENT reports appearing in the press have referred to the long distances attained by the projectiles of heavy guns in Europe. It was claimed, for instance, that batteries established on the French shore of the English Channel could reach England with their projectiles; and some time ago, it was reported that projectiles had been fired into Dunquerque from Nieuport, a distance of 21 miles.

These claims are not extravagant; and there would be no cause for wonder if there existed a more general acquaintance with the conditions which govern the flight of projectiles through the air and determine the distances to which they may be thrown; and in view of this, it seems timely to note the salient facts involved in the laws which govern and limit the flight of projectiles.

In the first place, other things being equal, the speed with which the projectile is launched, technically called its *muzzle velocity*, is of prime importance. The *range*, or distance which the projectile traverses before striking, is the horizontal distance from the *muzzle* (or mouth of the gun) to the point at which the projectile first strikes the ground. If the gun is level when fired, the projectile strikes the ground almost immediately. The distance or range increases as the muzzle of the gun is raised; and this increase continues until the gun has been elevated to an angle above the horizontal approximating to 45 degrees, or half way to the vertical position. Upon further elevation of the muzzle, the range begins to shorten, slowly at first, but with increasing rapidity, until, finally, when the muzzle is pointing directly upwards, the projectile falls back to the ground at the gun.

The simplest case conceivable is that of a projectile encountering no resistance from the air, but simply obeying the downward pull of its weight in conformity with the law of gravity. Such a case is illustrated in Fig. 7, which shows trajectories for elevations of 15, 30, 45, 60, 75 and 90 deg. above the horizontal. The muzzle velocity assumed for the trajectories shown is 4,000 feet per second, or about 2,700 miles per hour, as this is about the highest velocity that has been obtained with projectiles of ordinary design, even with special guns.

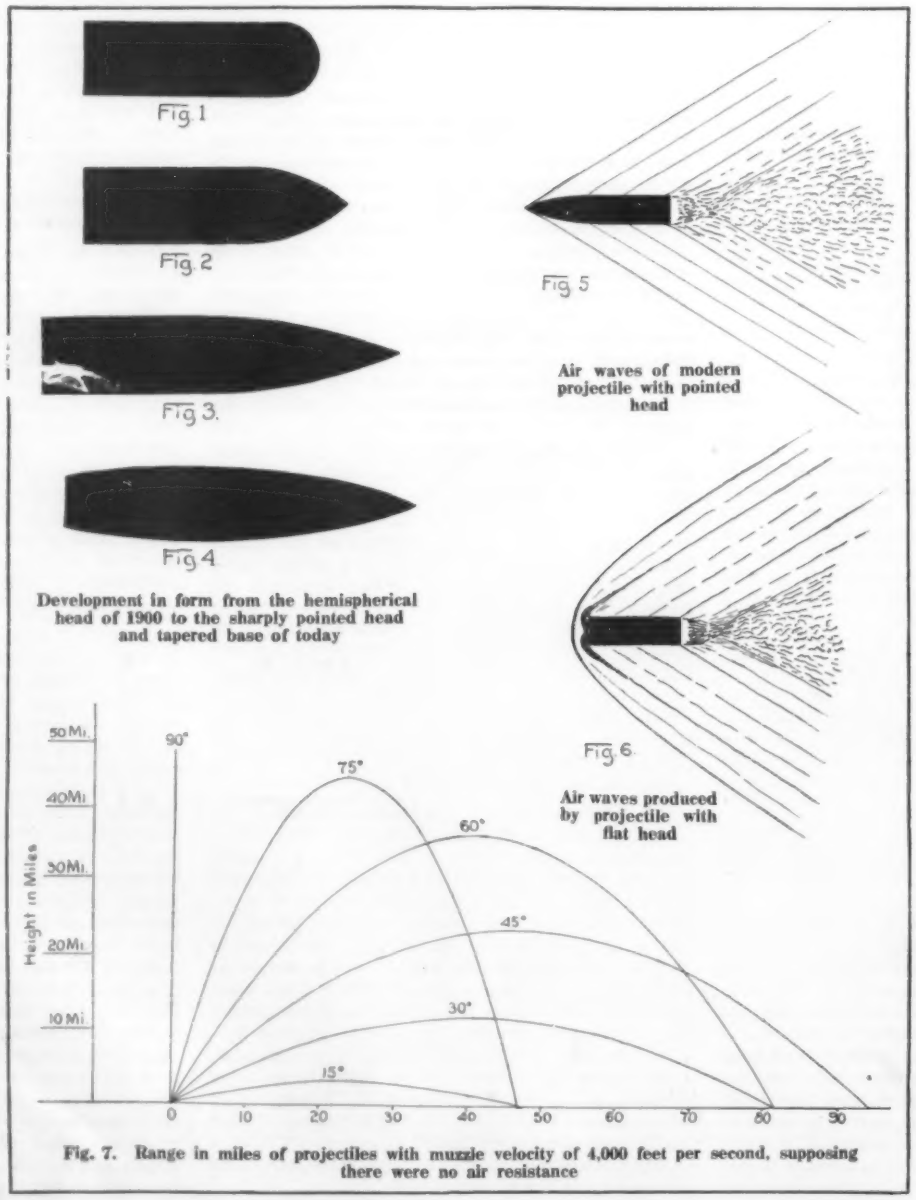

Fig. 7. Range in miles of projectiles with muzzle velocity of 4,000 feet per second, supposing there were no air resistance

It is to be remembered that these are the greatest possible trajectories that could be attained with this high muzzle velocity. For in them there is supposed to be no air resistance, whereas, in actual trajectories the resistance of the air materially affects the form of the trajectory and shortens the range. Trajectories of the kind illustrated in Fig. 7 may be regarded as the limiting ones to which the trajectory of even the most perfect projectile can only approach.

Examination of Fig. 7 will show that for the unresisted motion there considered, the range at 15 deg. elevation is the same as that at 75 deg., though the height of the trajectory in the two cases is widely different. The range for 30 deg. is the same as that at 60, and in general the range is the same whether the angle be measured from the vertical or from the horizontal. The greatest range is at 45 deg.

For other muzzle velocities than 4,000 feet per second, there are given below the ranges in miles, the greatest height attained by the projectile in its flight, also in miles, and the time occupied in describing the trajectory:

Muzzle Velocity, f. s.	Range in Miles.	Height Ascended. Miles.	Time of Flight. Seconds.
2,000	24	6	88 or 1 min. 28 sec.
2,500	37	9	110 or 1 min. 50 sec.
3,000	53	13	132 or 2 min. 12 sec.
3,500	72	18	154 or 2 min. 34 sec.
4,000	94	24	177 or 2 min. 57 sec.
4,500	119	30	199 or 3 min. 19 sec.
5,000	147	37	221 or 3 min. 41 sec.

Under the conditions of unresisted motion, the weight and form of the projectile are immaterial. For example, with 4,000 feet per second as muzzle velocity, and without air resistance, an infantry bullet of whatever weight or form would, with 45 deg. elevation, shoot 94 miles or from New York to Philadelphia, and would rise 24 miles into the air in doing so. It would occupy a little less than three minutes in making the journey. This performance would be exactly duplicated by the very largest projectile that it is possible or ever will be possible to make.

For identical conditions as to

muzzle velocity and elevation, ranges in air are, in general, far shorter than those just described; and it has been the effort of ordnance engineers to so design projectiles that they shall suffer the least possible resistance in their flight through the air.

It is natural that, at first sight, the resistance of the air to the motion of a very heavy projectile should seem an insignificant matter. For velocities below about 200 miles an hour, such resistance does not produce any great effect on the motion of projectiles; but, as the velocity increases the resistance increases at a far greater rate, and in practice is of such importance that a trajectory calculated without taking it into account would be hopelessly in error.

The size and weight of both guns and projectiles have been greatly increased in recent years. In this way, the efficiency of the projectile in overcoming the resistance of the air has been increased; but at the same time the increase in muzzle velocity which has formed so important a part of the development has entailed correspondingly greater air resistance and has thereby tended to counteract the greater efficiency of the projectile. It was therefore found necessary to seek a form of projectile which would meet with sufficiently reduced air resistance to counteract this adverse tendency. This was successfully accomplished by making the head of the projectile longer and more pointed.

Originally, the oblong form of projectiles which came into use when rifles were first employed had a hemispherical head or one very nearly so. The shape of this head is shown approximately in Fig. 1. Fifteen years ago the standard form of head was that shown in Fig. 2. At the present time, the commonly accepted standard form is that shown in Fig. 3. The curves of these heads are simple circular arcs, that of Fig. 1 having a radius of one half caliber (or diameter of projectile), that of Fig. 2 a two caliber radius and that of Fig. 3 a seven caliber radius. There is now a tendency to still further modify the shape of the projectile by employing other curves than simple circular arcs for the head, and, in addition, tapering the rear portion of the projectile, as indicated in Fig. 4.

Examination of Fig. 5 and Fig. 6 will give an idea of the manner in which a projectile generates waves in its progress through the air. These figures were drawn after examining numerous photographs of projectiles in flight. The camera is able to detect air disturbances that would be invisible to the eye, even if there were time to see them. For the velocities in ordinary use, the projectile outstrips these waves and leaves behind it a vacuum, the flow of the air into which produces the violent eddies noted in rear of the projectile. Tapering away the rear portion of the projectile materially reduces these eddies; but, if carried to extremes, it would cause the flight of the projectile to become very erratic. The extent to which the tapering process may be applied with practical advantage has not yet been completely determined.

Comparison of Fig. 5 and Fig. 6 shows in contrast

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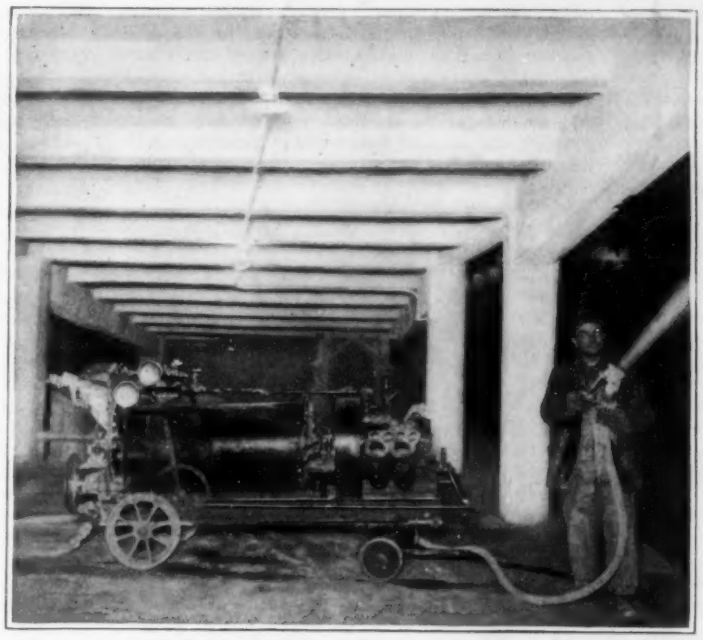
Conveying and Applying Concrete by Steam

THE concrete contractor must necessarily solve the problem of the economical conveyance of concrete from the mixing plant to the point of use. This was a great question at Panama, particularly at the Atlantic locks and the Pacific locks. In the one case, it was solved by a combination of tramway and self-propelled, movable cableway; in the other by self-propelled, movable, T-shaped cranes. On one of the great recent viaducts built by the Lackawanna Railroad, derricks were employed. At Baltimore, on a big job, a line of elevator towers provided with chutes is being used.

What is perhaps the most recent method actually tried out upon important work operates through the agency of superheated steam. The concrete is transmitted through a tube by means of steam pressure.



Applying crushed marble mortar to the walls and ceilings at the Grand Central Station, New York, with a concrete atomizer

At the point of use, the concrete is ejected from a nozzle in the form of a spray. Particles and pieces of cement, sand and stone are shot like projectiles from a gun. However, the concrete has undergone a mixing process before being sent along the pipe line.

Naturally, the concrete is deposited as a layer. The thickness may be no more than ⅛ inch or even less, or it may be more. Layer may be added to layer and any thickness desired built up. It must not be concluded from this, however, that the procedure is unsuited for depositing heavy amounts of concrete. A rather small machine has transmitted concrete a distance of 300 feet and placed it at an expense of 80 cents per cubic yard, the cost including fuel and labor. The expense for a larger machine has been given as 30 cents. If, as is claimed, the finished concrete is stronger per unit of volume than ordinary concrete because of increased density, then there will be a further reduction to be taken into account.

The general procedure is substantially as follows:

The materials are put into one end of the machine where they are mixed mechanically by a device rotating on a horizontal axis. During the mixing, superheated steam at a pressure of about 80 or 85 pounds per square inch is admitted. The result is in part a raising of the temperature of the concrete. After the mixing is complete, a valve is opened which admits the batch into a second compartment, the atomizing chamber. But this chamber, and the transmission line into which it opens through a valve, has been previously filled with steam at a pressure of about 35 or 40 pounds. Accordingly, the pipe will have been warmed up and also cleared of obstructions. The opening of the valve between the mixing and the atomizing chambers results in a transfer of the concrete into the mixing chamber with the possible aid of the mixing paddles. The steam pressure will become equalized and the concrete suffer "atomization." Finally, when the valve controlling admission to the pipe line is opened, the disintegrated concrete will be forced along the tube.

A little consideration will show the importance of preheating the concrete and the transmission line. If the steam should condense, there would be an instantaneous annihilation of its pressure. This is, in fact, one of the principles upon which the condensing steam engine depends for its action. Consequently, the steam is used superheated—with heat enough and to spare. Further, the steam should be hot enough at the nozzle to maintain itself as steam for a short distance after it reaches the open air. This is advisable, though perhaps not absolutely essential. If the steam at once condenses, then the spray of concrete will be enveloped in a cloud of steam vapor, with the result that the placing operation is more or less shut off from the view of the man operating the nozzle.

The steam method has been employed on good sized jobs for the United States Government and for important railways. Some 30 miles below New Orleans, it was deemed expedient to protect by a layer of concrete the face of the levee. The steam atomizing process was applied upon this work and a considerable length of covering put on. There was no reinforcement employed or any means of securing the covering to the embankment beyond what the method itself supplies. As the particles and pieces of concrete are projected with considerable velocity, there is a very considerable tendency to secure good adhesion. The embankment is a 1-on-2 slope, so that it is not steep. The covering was put on 2 inches thick.

The Lackawanna Railroad, one of the great believers in concrete, utilized the steam method in restoring two old water conduits at Rupert, Pa. These are waterways which pass beneath a canal bed and supply an ancient mill. The diameter is about 5 feet and the original lining was stone. The mortar had fallen out to a great extent, leaving the surface extremely

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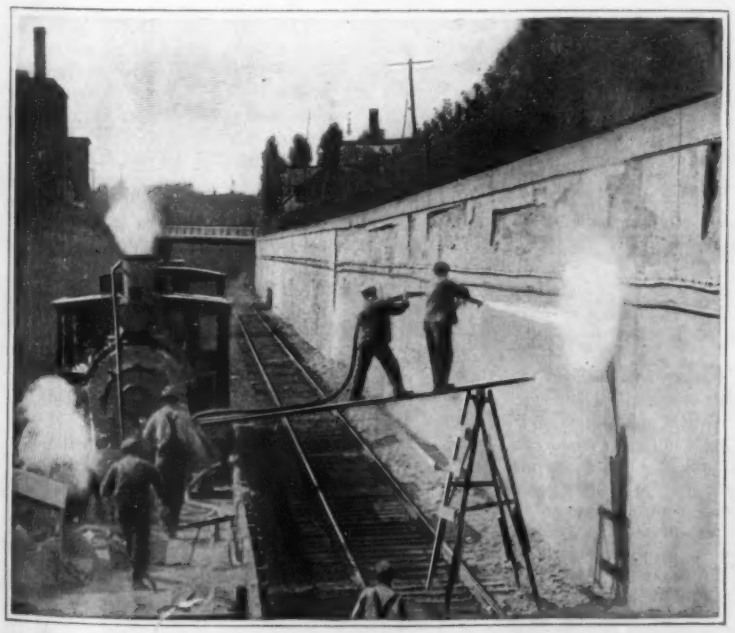


General view of the concrete atomizer equipment employed by the Lackawanna Railroad at Newark, N. J.

Applying concrete on a wall, using the concrete atomizer operated with steam

Strategic Moves of the War, March 31st, 1916

By Our Military Expert

FAR reaching activity has become apparent on the Russian front within the past few days. It is rather difficult to say at the date of writing, which unfortunately is somewhat prior to date of publication, whether or not this activity on the part of the Russian forces marks the initiation of a general offensive.

There are several reasons for the belief, however, that the long looked for offensive of the Entente has not yet begun. First and foremost is the condition of the ground. The rigors of winter have locked the eastern front in an iron grasp up to now and the spring thaw is about to set in. During this period the terrain over which most of the line winds will become almost a morass, rendering movement difficult in the extreme and complicating the problem of supply for the enormous Russian forces which are already handicapped by a paucity of railway communications, much less efficient and ample than those of the Teutons.

The second reason is to be found in the conditions which will exist along a great part of the Russian line with the flooding of the thaw. From Riga to the vicinity of Rovno is to be found varying ground. Some few eminences establish safe and important posts in the Russian line, but the majority of the line in this extensive section is on low ground; and when the waters of the melting ice-grip begin to flow, many of these low positions will be rendered untenable by their present occupants. On the other hand, the Germans are generally established on higher ground and the thaw will not have so disturbing an effect upon them. It has been said that Field Marshal von Hindenburg comprehended this and halted his autumn drive towards the heart of Russia before it was necessary, in the hope that spring conditions would compel automatically a retirement of the Russian lines to a position a considerable distance to the eastward of where they now are.

The Russian activity, then, may be altogether dictated by realization of the approaching condition and the necessity for either gaining higher ground from the Germans, with the possibility of successful penetration of their lines, or else evacuating a considerable portion of the line.

There is a notable similarity between the German offensive at Verdun and the latest Russian movements from Riga to well toward Pinsk. It now seems as though Germany's efforts were directed toward removing a possible spring menace against Metz—always with the possibility of breaking the line through fortuitous circumstances; Russia's attack seems to be for a similar purpose, to protect the territory back of her present position. But there the similarity ceases, for it also appears as though Germany, in her Verdun operations, hoped to provoke the Entente into a premature assumption of the offensive, or counter-offensive, rather; and Russia scarcely entertains such a desire. Germany has never yet engineered two major offensives at the same time. There are not the men for it, when one considers the enormous number necessary for even one such operation.

A great deal of the ground along the Russian line is difficult in the extreme. Southwest of Riga, in the Lake Babit section, the marshes of *Marais Trroat* extend as far eastward as Dahlen. For the time being, the ground is more favorable along the Dvina, high ground marking both banks, through Friedrichstadt and Jakobstadt almost to Dvinsk, where the Russian line stiffened against the assaults the late autumn saw hurled against it.

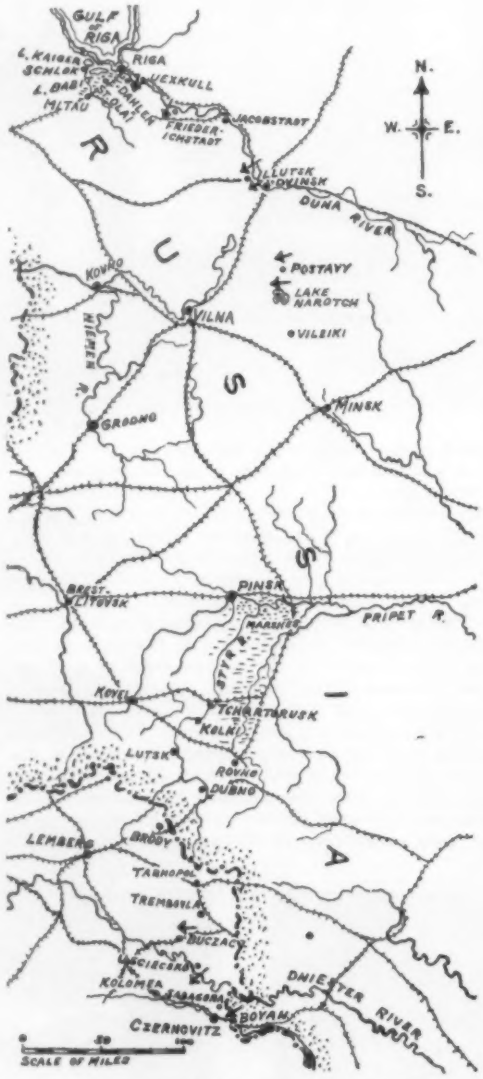
But to the southward of Dvinsk, the real trouble begins. A broken chain of lakes and small, tortuous streams lace the terrain. The ground is generally low with frequent marshes, which, while small, are none the less serious obstacles to advance in the modern day of tremendous rapidity and volume of fire. South of Lake Narotz, the character of the country is a trifle better for the absence of lakes; but still farther south the extensive marshes which begin in the neighborhood of Pinsk, line both sides of the Styr and terminate only a short distance north of the fortress town of Rovno, where reasonably high ground again obtains.

It is clearly to be seen that the position is by no manner of means an agreeable or acceptable one for the Russians. Should circumstances demand that the present position be held during a most probable resumption of the offensive by the Germans with the coming of suitable weather, the Russian sectors in the above-described country would be seriously limited.

A strong Russian attack has been launched along the Riga-Dvinsk-Narotz front. Success or failure does not now result in a day, so it is impossible even to venture an opinion as to problematical success or failure of the attack. Where information from the scene of operations is as scarce as it is to-day, no man dares prophesy on such scant data, even were he presumptuous enough to try; so time alone can tell the outcome.

To a people who are given to thinking—and reading—in headlines, huge numbers of losses are apt to secure consideration for themselves alone without suggesting comparisons; therefore the featuring by the papers of the news item from Berlin that 80,000 Russians have paid the price of attack on a front of 120 kilometers, suggests a little consideration.

This loss is comparatively small. One hundred and twenty kilometers is about 75 miles; and, apportioning the losses claimed by Berlin gives something slightly over a thousand men per mile. Compare this with the Teutonic losses before Verdun—on a front of less extent; these losses have been placed at 250,000 men and no one can dare say that a man was thrown away foolishly, for these attacks were pressed home with magnificent courage and impeccable military purpose. The losses at Verdun have been six times as great per mile as those of the Russians, reported from Berlin. True—Verdun attacks lasted over a greater span of time, but the relation of attack to attack suggests, first,



Europe's eastern battle front. Russian activities indicated by arrows

that the Russian offensive has not been developed in such concentrated strength and, second, that they have met no such solid defense as has marked the holding of the Verdun lines.

Other, and sporadic activity has developed among the Russians in Bokovina and south of the marsh district; this may portend a real offensive in the section, now or later. But it is probably merely the accompanying action to larger movements that opposing lines may not be stripped of men for use further north. There seems to be good reason, however, why a strong Russian attack in this neighborhood at the present time might have an important political effect upon swaying Roumania actively to the side of the Entente. While it is generally acknowledged that the individual sympathies of the Roumanians incline toward the Allies, the mere fact that their state has been held concretely neutral accrues as a diplomatic triumph to Teutonia, for tremendous pressure has been brought to bear to precipitate Roumania into the fray.

The suggestion that the present Russian activity does not altogether mark the initiation of general offensive by the Entente brings up the question of the long-expected assumption of the offensive by the exterior Powers. Military writers and historians have generally looked for a counter movement to meet the German onslaughts at Verdun; and it has not come; they have predicted—and hailed—such a movement with all the elements of the Entente employed—and it has not come. There must be a reason somewhere, other than seasonal. Perhaps there is a certain dis-similarity to the course of other wars when public opinion demanded action instead of adequate preparation.

Those who lived through the turmoil of the American Civil War can readily recall the general cry that surged up during the first two years—"On to Richmond." And history that cannot be denied tells how this cry was heeded against the judgment of military minds and the protests of McClellan, then in command of the field army, with the interfering Halleck, into whose distracted ears the babel clamored, directing operations from a swivel chair at Washington.

The American Civil War and the Franco-German are the bases upon which modern military science has been predicated. Each campaign, battle, skirmish, has been conned and the minor deductions consolidated into a whole of theory, precept and axiom. And the French staff, as well as the German, has apparently taken the lesson of unpreparedness and premature action to heart. At the outbreak of the present war, Germany was prepared; France, despite popular conception, was not; England was not; Russia was not; Italy took a year to prepare before plunging in. The deduction seems obvious.

It would seem that some unshakable military council has decided not to be hurried into inadvisable activity prior to full preparation, despite the wails and warnings of scribes and dinner-table strategists, even despite the natural unrest of engaged peoples, and neutral populaces as well, who know war only by its heroic or dreadful side. It is very evident that France was not hurried into a premature offensive return by Verdun and it is a natural corollary that neither will any element of the Entente again essay full-strength action until the time is ripe, and the ammunition plentiful. Perhaps, after all, a war genius, now somewhere in obscure control of affairs, may yet emerge upon the pages of history's perspective.

Extensive Use of Sunglasses in India

IN many parts of India there is extensive use made of sunglasses. Most Europeans wear them a good part of the year, owing to the intense glare of the sun. Roads in that country are generally paved with macadam made of white limestone. The lack of trees in certain districts to shade either city streets or most country roads, and the flat formation of a large part of the country, cause a reflection that is very trying, even when one wears a topee or sun helmet.

Two types of sunglasses are chiefly in use in India. One is a glass of the pince-nez variety, with solid rubber sides made to pinch the temples. This gives a double grip and the sides aid in shading the eyes. The second type has sides of cloth, arranged on springs, so that they are held fast to the outside of the eyes at the temples and, with the glass, completely inclose the eye. When closed, the side pieces are pressed down by the ear pieces. These glasses are of the spectacle kind. There is also sold, in addition to the two foregoing varieties, a glass of the spectacle kind, which is simply a large, round, colored glass of about 1½ inches diameter, without side pieces. The colors of the glass used in the sunglasses are green, blue and gray. A kind of modified green is now most popular. Gray is not as commonly used as either light blue or green.

Tests for Gum Arabic

A STUDY of many of the published tests for gum arabic, with descriptions of attempts to find others than the few that proved to be reliable, has been published by the United States Bureau of Standards. It was found that basic lead acetate gave the most characteristic reaction, while mixtures of copper sulphate and sodium hydroxide and of neutral ferric chloride and alcohol are of value as confirmatory tests. Dextrin and gum ghatti were subjected to the same tests. A summary of the more important methods that have been proposed for the quantitative estimation of gum arabic is next given, followed by a description of the steps that led the investigators at the Bureau to the use of alcoholic copper acetate-ammonia solution for its determination.

Naval Consulting Board's Committee on Industrial Preparedness—II

Initial Difficulties Encountered by American Manufacturers in Meeting Munition Specifications

IN our last issue we gave an outline of the comprehensive plan which has been adopted by the Naval Consulting Board's Committee on Industrial Preparedness, for mobilizing the nation's industries for war. It was explained how the committee proposed to make a card index of the manufacturing resources of the country, utilizing for this purpose the services of an expert body of 30,000 of the technically-trained engineers of the United States. In the present and concluding chapter we are enabled, through the courtesy of Mr. Bascom Little, president of the Cleveland Chamber of Commerce, to throw some further light upon the difficulties encountered at the very outset of their work by the concerns in this country which secured contracts for the supply of munitions to the Allied forces.

We are informed by Mr. Little that the thing which has stirred up the business men of the Middle West has been the extraordinary and totally unforeseen difficulties which the manufacturers encountered at the very outset in their endeavor to make quick deliveries on the contracts which they had undertaken. The problem looked so easy and so profitable when it started a year-and-a-half ago, that everybody concerned expected that right away would be an increase in the dividends of the companies which went into the business. As an instance of the difficulties and delay which were experienced at the very outset, he mentioned the case of a large firm in the West which signed a contract for 250,000 3-inch high-explosive shells. On the face of it this was a straightforward job; merely a matter of machining. The forgings were shipped to the company, and they were supposed to finish and deliver them. At about the time when the forgings began to be delivered to the works, information from the front in Europe brought home to the company the fact that this whole order that looked so big to them, was less than one day's supply for France or England or Russia; and the concern realized that within eight months, by turning its plant—a first-class machine shop—on to this job they could make just one day's supply for one of the Allies. Soon after manufacture commenced, the firm found that it could do everything in connection with the making of that shell very successfully, except at one point in the process—the hardening. That was 15 months ago. At the present time the concern has shipped and had accepted 130,000 shells. These, however, are not complete; they have yet to be fitted by the fuse maker; they have to be loaded; they have still to be fitted into the brass cartridge cases with the propelling charge; and somewhere, sometime, maybe, said Mr. Little, they will reach the battlefield of Europe. Up to the present time none of them had got there.

The same experience has been had in so many plants in the Middle West, that the people out there have made up their minds that, if they are ever going to be called on for the service of the nation, they have to learn a great deal more about this business of making munitions; they feel that in their present condition of inexperience, in the event of war they would prove to be liabilities to the nation and not assets. Hence the National Chamber of Commerce has been trying to figure out what sort of relation these private plants should have to the Federal Government both in times of peace and in times of war, and it has developed, at least to its own satisfaction, the fundamentals of the following plan:

The Chamber of Commerce believes, in the first place, that there ought to be a contractual obligation or connection made in the open market, in much the same manner as a firm would do business with any other customer, but with this main difference: that in case of war there should be no excess profit to anybody arising out of the national necessity; that the Federal Government should have the use of the private plants of this country, in case of war, at a living wage to the stockholders (since it is economically undesirable that the stockholders cease to have any dividends from their investment), but that the Government should have the right to take over those plants, with their personnel and equipment, on the basis of a living wage, so as to prevent even the suggestion of a profit-interest in war. For the National Chamber of Commerce, said Mr. Little, feels that it is very unsafe and very undesirable to set up any kind of an organization which will make any part of a community interested in forcing the nation into war; that if there is a war, every person in the nation must accept his share of the national sacrifice and must turn in and work in whatever place his ability, his individual productive capacity, can be best applied.

It was noted in the last issue of the SCIENTIFIC AMERICAN that the National Chamber of Commerce is working in coöperation with the Committee on Industrial Preparedness, and the plan for governmental coöperation as at present outlined, is as follows: The proper office in Washington looks over the detailed information regarding the industrial facilities of the country as secured by Mr. Coffin's committee, and taking up the case of a certain plant "A" it decides that the equipment of plant "A" is such that it is adapted for making, let us say, shrapnel fuses. The Government then enters into contract with the plant, which undertakes to make a complete set of tools, dies, jigs and fixtures for turning the total productive capacity of the plant into the making of that very article. The plant contracts to store that particular article in its storeroom and have it ready; and to pay for that the government agrees to a minimum annual order in peace-time for that product. This contract should also carry with it the option to lease by the Government at an agreed-upon price, either on a cost-plus-a-profit basis or at a guaranteed percentage of dividends on the stock. The Government officials would not attempt to operate that plant during war-time. The manager, the foreman, the skilled workmen, would be back on their jobs the next morning after a declaration of war, doing the same things they did the day before; but they would be in uniform, or at least they would wear a distinctive badge showing that they were in the Federal service. The Federal Government gives the plant an insurance policy, guaranteeing the return of the physical property of the plant at the end of the war in as good condition as it was when taken over, less ordinary depreciation, which of course, would be absorbed in the profits as it is in peace-time. It is the opinion of Mr. Little that the above plan is a perfectly sound proposition; one that will produce the peace-time products required by the Government so far as war material and supplies are concerned, and that will produce them at less price than they now cost the country. Furthermore, it will provide an immediately-expandible system, such that in case of war the production of the country can be multiplied a hundred times within a very short period.

Thus far no plant which has a production of less than $100,000 a year is proposed to be included in the organization, and it is believed that these concerns (something over 30,000 in all) will gladly enter the proposed organization.

Some illuminating facts bearing upon this question of our industrial unpreparedness were brought out recently by another Western manufacturer, Mr. Henry Souther, a member of the Naval Consulting Board, in the course of his independent investigation of the ability of manufacturers to accelerate the output of their normal product. He was informed by the president of a large New England firm engaged in the manufacture of firearms, that the maximum of their output will not be reached until October of this year. This firm had a factory twice as big as they could use: nevertheless that factory will not be full of machinery and producing munitions to its utmost capacity until over two years after it began to get busy on its contract. This firm, said Mr. Souther, knew the game—what then must be the plight of the manufacturer who does not know the game? It is his conviction, and we fully agree with him, that if the American public could be made to see and appreciate what a mess we have made of the foreign orders for munitions, and would make of it if we were pressed with war orders for our own Government, they would demand that their representatives in Congress put the stamp of legislative approval upon the present plan for industrial preparedness.

As showing the many-sidedness of this munitions question—how it bristles with perplexing difficulties—Mr. Souther drew attention to the case of the inspectors who are being sent out broadcast in the United States, to-day, to inspect the goods which are being made for the foreign powers. The inspector is generally a green man. He reads certain specifications and he is handed certain gages; but he reads without the necessary intelligence and handles his gages without the proper skill. It is difficult for such an inspector to realize the requirements, let us say, of the base of an ordinary, copper, cartridge-shell. This was illustrated by the rejection of one lot of 80,000 3-inch shells because they were undercut in the primer seat, an error which caused the exploding charge to expand and seize the primer, and so rendered the thing absolutely useless. This rejection occurred simply because the manufacturer, for lack of experience, did not realize the importance of that one little item. It has taken our motor car builders 15 years to get the gears of the rear axle, said Mr. Souther, sufficiently strong and sufficiently quiet and sufficiently other things to make a good rear axle. How in the world, then, can the manufacturers of this country jump in and realize at once all the requirements of a rifle, of a shell, of an aeroplane engine, or any other of the means and implements of modern warfare?

In concluding our digest of the plan of operation of the Committee on Industrial Preparedness we feel that it is only common justice to emphasize the fact that its President, Mr. Coffin, who is one of the pioneers and leaders of the American automobile industry, has been so patriotic as to give his undivided time for a national service without compensation. It is neither fair nor just that this gentleman and others who are associated with him in such work should be asked to do this permanently without full legal authority from Congress, and the question arises as to whether the time has not come when this committee, or the Naval Consulting Board, should not be directed by law into a Council of National Defense to sit in Washington. As we pointed out in a series of articles on the needs of the Navy, published several months before the opening of the present war, there has been for several years a movement on foot among our naval and military men, which has sought to bring before Congress the great need for a Council of National Defense, which shall include the Secretaries of War and of the Navy, the Chief of Staff of the Army, the Naval Aide for Operations, the Chairmen of the House and Senate Naval Committees, the council to be presided over by the Secretary of State as representing the President. A bill broadly to this effect will be brought up before Congress during its present session, and we are strongly of the opinion that both the Naval Consulting Board and its Committee on Industrial Preparedness should have a strong representation in such a council.

The Current Supplement

IN the issue of the SCIENTIFIC AMERICAN SUPPLEMENT of April 8th, No. 2101, will be found *The King of Elephants*, an article of special interest describing an immense straight tusked elephant, the remains of which were first discovered in England several years ago, but only recently fully investigated. In size this monster far exceeds that of the great American Mammoth. There are several illustrations, including a reproduction of this unusual specimen. A subject that will be of interest and value to a large number of readers is *Making Wild Animals Take Their Own Pictures*, which describes the ingenious apparatus and methods by which a busy engineer secured many curious nature pictures. It is illustrated by a large number of cuts showing the details of the apparatus used so clearly that anyone can easily reproduce the outfit. *The Specificity of Proteins and Carbohydrates in Relation to Genera, Species and Varieties* is another paper that will be of interest to the scientist. There is a short illustrated description of *The Washington Navy Yard Wind Tunnel*, which is used in the solution of various aeronautical problems. The valuable article on *Food Selection* is concluded. When the Parliament Building at Ottawa was destroyed by fire recently quarters for the Dominion Government were immediately provided in the Victoria Memorial Museum. An article by one of the museum staff tells how the arrangements were accomplished, and there are illustrations of the museum and its interior. *Salts, Salt-Colloids and Soils* treats of problems of reclaiming and maintaining waste alkali lands. *The Surface Tension at the Interface Between Two Liquids* discusses an important physical problem. Ghost Lines discusses phenomena observed in large steel castings. Other articles of interest are *The Utilization of Peat*, *The Ignition of Explosive Gas Mixtures by Electric Sparks* and *Ancient Principles of Physiognomy*.

Extermination of Locusts in Argentine Republic

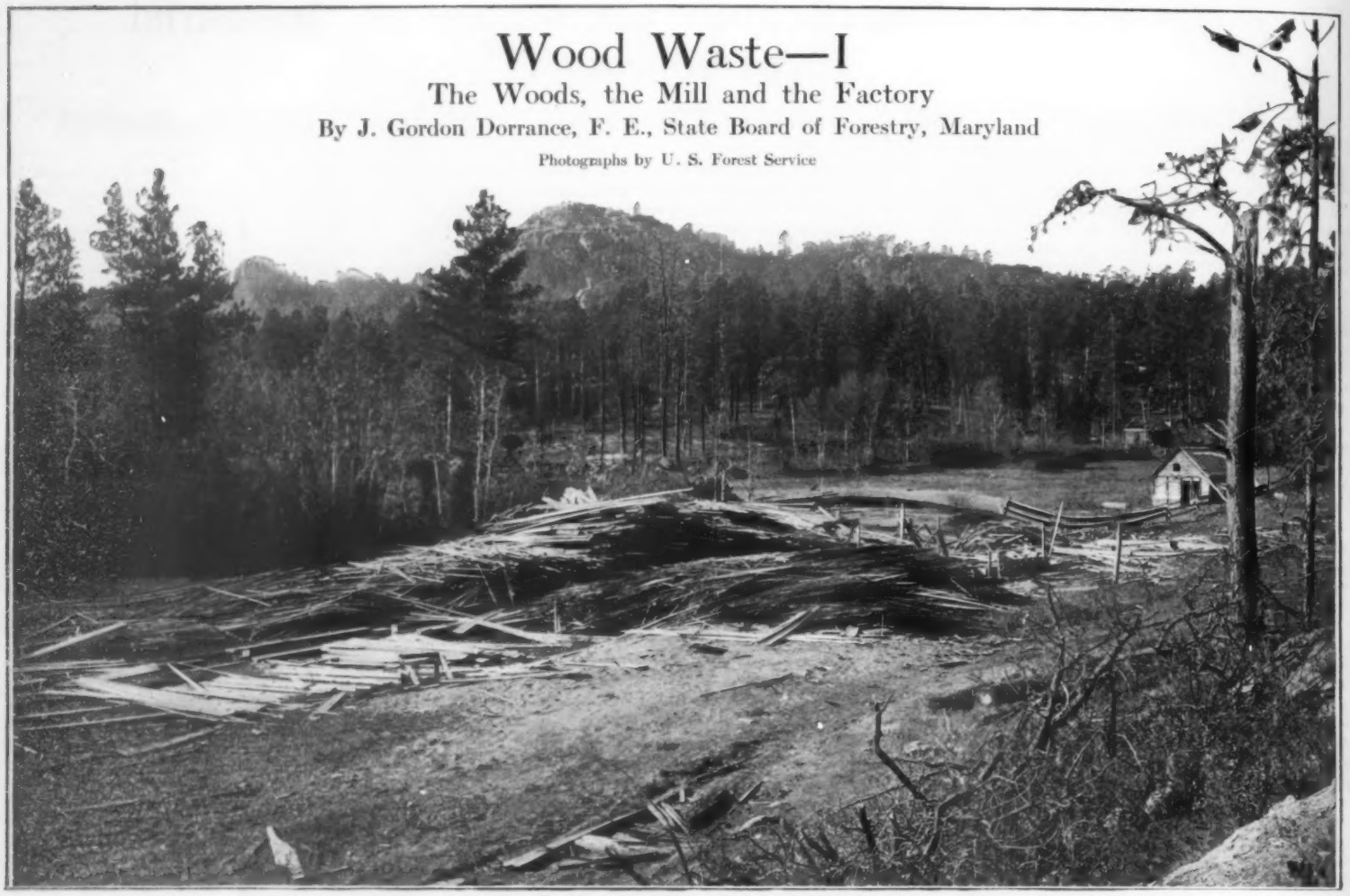
SCIENTIFIC research by the Argentine Department of Agriculture has established the fact that the locust, as well as other destructive insects, has a natural parasite enemy. The Department recommends in a recent issue of the *Boletin Oficial* that the directors of the National Institute of Bacteriology, and the section of applied zoölogy of the live-stock bureau coöperate in a study and application of the best means for the propagation of the locust's enemy, since experience has proved this method of attack to be most effective in similar cases. The sum of 500,000 paper pesos ($212,300) has been appropriated to be used in various ways in the campaign against the locusts.

Wood Waste—I

The Woods, the Mill and the Factory

By J. Gordon Dorrance, F. E., State Board of Forestry, Maryland

Photographs by U. S. Forest Service



Mill waste. The sawmill has been, in the past, one of the most prolific of the forest "wasters"

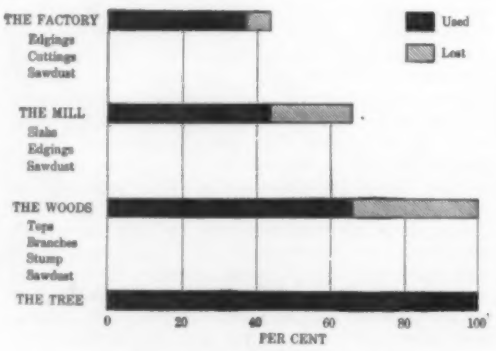
THE first forests of the United States covered not far from 900,000,000 acres of land, and their timber exceeded in quality and amount, in variety and value, that found in present or past times upon any area of equal size. They are estimated to have contained in merchantable timber not less than 5,250,000,000,000 board feet. It was not evenly distributed over the country as a whole. Along the Atlantic seaboard from Canada southward to the Gulf, in the Great Lake regions, and still farther West, were great unbroken areas; these areas were interrupted by the Plains, but again, in the Rocky Mountain ranges and along the coast of the Pacific, occurred first stands of timber which were remarkable, and which will probably never be found again in any portion of the world.

The American, whether the pioneer of three hundred years ago, or the business man of now, was rarely backward to see or grasp his opportunity. The first thing he saw in America was its forest, and where he went it was the first to go. The pioneer settler was the pioneer logger and millman, and the early sawmills were never slow to follow the first clearings in the new land, where plants for the manufacture of lumber antedated by much over a century those in the land he had left. Often this mill was nothing more than a crude improvement of the first pit-saw, in the beginning operated only by hand, but the mills grew with the country, and soon great wheels were being turned by wind or water power—wheels and mills quite often capable of grinding grain as well as sawing boards for their few scattered customers in the American wilderness.

Method of Logging—Old and New

The prime objective in cutting and marketing timber now is money. Then necessity was the dictator, and very little cash changed hands. The *modus operandi* was to clear the land of the old crop to make way for the new. The former, the forest, stood in the way, and it had to go. The settlers were the means to the end, and their work fitted the needs of the times. It was well and thoroughly done. Whether by axe or saw, by girdling trees or firing the land on which they grew, the cut was clean, and the fresh soils set out to other and more remunerative crops. Destructive cutting was no doubt necessary, economically, for them; it may even have been desirable, for it reduced a great surplus.

It is neither the one nor the other with us, yet signs of the first-comers and their work are visible still, whether in the great forests of the South or in the others farther west, where, in the piles of waste wood left to rot or furnish a ready tinder for forest fires, in the high stumps, in the abandoned trunks of trees, or the sterile, eroded lands which often follow such cutting operations, there are found fresh proofs of this, all furnishing a commentary on present methods handed down from primitive days. There is more waste in the little mill town, with its hills of sawdust, and the smoke from hundred-foot burners which blackens the sky for each of the 24 hours of the day; and in the city factory's piles of unused wood or the pieces cut up for kindling, sound, clear pieces not large enough for fuel, and yet too good to burn. It is quite possible, in the heyday of milling in the White Pine forests of the great Northwest, that a fair-sized forest was whirled up in smoke every day, in the sawmill settlements alone, from the scores upon scores of mill engines and great sheet-iron burners—the engines doing their duty indifferently on green sawdust and slabs, the burners also doing theirs in a speedy consumption of great quantities of fuel thrown in as offering the easiest and quickest way of waste disposal. The White Pine forests are fast going, but such methods are not yet obsolete elsewhere.



Disposal of wood from tree to finished product

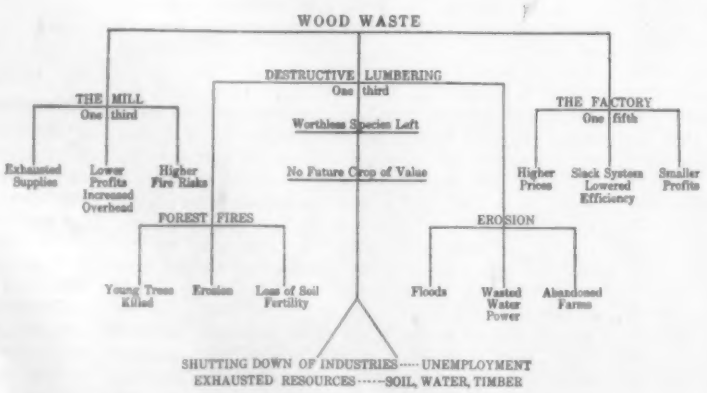


Diagram showing distribution of responsibility for wood waste

Scope of the Industry

It is the well-grounded belief of many conversant with these things that the production and manufacture of lumber and timber, and their products, by far exceed in importance any other industry along manufacturing lines. Lumber and timber products, at least, maintain first place in so far as the number of their establishments is concerned; branches of the one great industry support more wage earners than any other; they are second in value added to raw materials through manufacture; third in value of their products. Within the decade, 1899 to 1909, there was an increase of 36.6 per cent in wage earners; 51.9 per cent in products. Lumber and timber products, manufactures of lumber, and wood products of chemical processes now require 48,533 establishments; employ 907,514 wage earners; pay $422,764,807 in wages; and have a value annually of $1,582,522,263.

It is probable that the present yearly cut, inclusive of waste, is very nearly 25,000,000,000 cubic feet of wood. This total embraces the lumber production of 21,668 American sawmills, a cut which aggregated, in 1913, 33,387,009,000 board feet; and also, according to some figures of the National Conservation Commission, 100,000,000 cords of fire wood; more than 1,000,000,000 posts, poles, and rails; 118,000,000 hewn cross-ties; 1,150,000,000 staves, 133,000,000 sets of heading, and very nearly 500,000,000 barrel hoops; 3,000,000 cords of pulp wood; 165,000,000 cubic feet of round mine timbers; and 1,250,000 cords of wood for distillation. All this amounts, translated to more graphic terms, to 248 cubic feet of wood per capita per annum; it is about eleven

Discarded material. Portions of logs that could be utilized

Using fire to dispose of the wood waste of a factory

times the consumption of France; seven times Germany's figure; and practically three times the amount which is replacing it through growth. Neither does it include fire or insect damage, together destroying $75,000,000 to $100,000,000 worth of timber annually.

Were this all intensively used for the welfare and upbuilding of our own or other nations, it could, in large measure, be excused as a necessary element of construction and growth. Such a belief would be wide of the mark.

The Woods

Not many years ago I had occasion to visit some original White Pine forests in one of the Lake States, woodland since cut away. At the particular spot I have in mind a large lumbering operation was under way, and there was being carried on a heavy cut, both at the camps and in the mill. It was undoubtedly an average operation, both in stand of timber and methods of removal. Though White Pine was the principal species cut, outstripping other kinds both in value and stumpage, there was some growth of hardwoods, too. The loggers were ordered to cut the pine to a top diameter of 5 inches, which meant that the smallest trees, when cut to 16-foot logs, as was the practice there, must measure 5 inches at the smaller end, outside the bark. Hardwoods, clear, were taken to 7 inches, more common grades to 8, and the average stump-height for the smaller trees was slightly over 1 foot; for the larger ones, 2. All White Pine logs less than 12 feet long were left in the woods, as also most top logs which measured less than 10 inches at the small end, though the less valuable hardwoods, having a larger diameter limit, were admitted down to 8 feet.

Other camps nearby were visited, and the practice at the first seemed the rule at the rest. Nowhere was there particular care taken, through careful felling and hauling, for the protection of the remaining young growth in the removal of the old. Immature trees were cut, though later local mill practice showed plainly enough that a 5-inch tree in the log was good for little but a "sappy" two-by-four when sawed, and White Pine, matured, has better uses than for dimension. The cut was thorough, as a rule, and trees hollow at the base, yet good enough to have provided seed for another crop, were taken with the rest. At least they were cut. Sometimes they made one short log, and sometimes after felling they were shown to be unexpectedly poor, and lay where they had fallen. The trees of undesirable kinds or sizes, valueless, diseased, or overmature, as the case might be, were left in possession, and the stripped land was sold for poor farms which were rarely successful, because of climatic difficulties, or permitted to revert to the State, for nonpayment of taxes, as reforestation projects. There seemed hereabout an abundance of projects, but the reforestation was not apparent.

Fuel for forest fires known to lumbermen as "slash"

Stumps of trees which had stood in deep snow were very high, and now and then a tree was seen which had lodged against a neighbor, and ruined both. Visits to former woodland already covered, and left behind, showed a large amount of scrubby growth and valueless brush; occasionally a log left in some place which was a little hard to reach; deserted buildings with caved-in roofs, their sides still sound and built of good, straight logs; here and there construction material in corduroy road or log bridge, no longer needed or in use, simply left because it did not seem worth while to get it out. Farther along were sound sticks half-imbedded in the snow, lying where they had dropped from logging cars bound for the mill. The old forest was pretty thoroughly wiped out, and there was little for the new, save in the lops and tops left piled up anywhere, which, with the coming of another year, perhaps would aid a forest fire in killing the remnants and few young trees which might have struggled up.

The Mill and the Factory

At the mill town was a plant of higher than usual efficiency, half-hidden by a mountain of sawdust, while inside hogs ground up more slabs for sawdust to feed the engines or be blown to the hill outside. Trimmers and gangsaws were busied in cutting off defective ends or reducing odd lengths, for the grading of lumber then did not encourage the inclusion of odd lengths and random widths in boards, so that here alone was a daily waste of about 2,500 feet of perfectly sound and otherwise merchantable material. The results of this trimming, together with other slabs and edgings, were conveyed by an endless chain to the burner outside. The mill itself was confidently regarded as one of the best, for it wasted only one third of the logs which it manufactured.

Lumber from the mill was shipped out in a few months, after being air-dried in the yard, to a factory or wood-working plant. There some of the sawmill methods and wastes appeared again in great quantities of unused sawdust and shavings, with numberless long strips, and small, clear blocks from 2 to 6

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Effect of removing forest cover from sloping lands

Stumps and branches left behind as waste

War Game—IV

The Offensive Combat

By Guido von Horvath

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THE offensive combat has a distinct and positive aim,—to crush the enemy. To accomplish this, the forces taking the offensive must have or must gain a superiority. The method of directing the offensive in combat is the way of the strong against the weak.

It would, however, be a mistake to measure strength by numbers alone. Superior leadership is a far greater factor. And this factor, except in cases where the numerical superiority proves unsurmountable, will be decisive. This is the reason that the offensive, the aggressive, has been the policy, the ideal, of every great military leader. In the offensive operations of great generals we can find the bravery, the steadfastness and the boldness of genius. Even where circumstances make it necessary to resort to defensive action, the going over from the defensive to the offensive at the right moment, the offensive return, has always marked the culminating point of superior leadership.

Nevertheless, it would be a mistake to attempt to overwhelm the enemy everywhere at the same time. Properly, the aim must be to concentrate overwhelming forces and to direct the supreme effort against a decisive point.

To accomplish this object all the available forces must be utilized toward one aim, and it will be necessary for every commander to formulate his plans at the earliest possible moment with this one end in view.

A study of the offensive action of a Company in the third War Game will serve as an example of offensive action. But the knowledge of this is by no means enough to achieve success; many other considerations must be added to gain this end. Among these are: *The proper employment of all the available forces to prepare the way for the decisive thrust; to attract the enemy's attention, and to hold him to the ground where it is most desirable that he should remain; to wear down his power of resistance; to subjugate his will by superior tactics and to force him to submit to the prepared decisive action.*

Try to get a vivid picture of our battlefield in mind and, by use of the tactics of the Company, find the way which will enable us to do all these formidable sounding things. Our field of action is, in many ways, superior to that of the enemy coming from the north. The gently sloping northern side of Lookout Hill gives opportunity for a rapid dash forward, but offers no cover whatever, nor is there a direct chance to get at the enemy in the final attack with the bayonet. The creek will be found a good defensive line, as will also the lake.

It is evident from Colonel K's order that our forces hastened to occupy Lookout Hill. Now, let us suppose that they are established on the little plateau around Argus Farm. To the right is the rather steep and wooded hillside, with railroad and road crossing it; to the left is a far stretch of open country, then comes the broad Lebanon Forest. This stretch is a little over three miles wide, which is too wide for a force the size of Colonel K's detachment to span. What are, and where are the advantages of which we speak?

Let us return to the items which are emphasized in the foregoing paragraph and see what could be done to prepare the way for successful action.

One thing has already been accomplished: Colonel K has secured the bridges for the division to cross by succeeding in reaching Lookout Hill, which dominates these bridges.

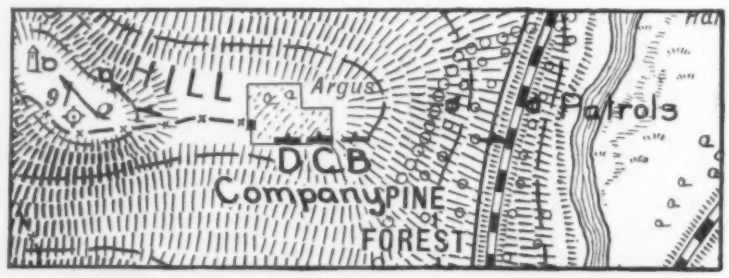
Through this action, and Captain C's timely interference, and the destruction of the railroad bridge, the enemy has been forced to make a detour. More, his attention has been attracted by the cavalry and the artillery. The next step is to hold him in the position best suited to our operations. Is Timcum Creek the location desired?

The enemy has occupied the stretch between Nehaminy River and Green's Lake. It is a good defensive position, having the flanks well covered by the river and the lake. Its left wing is, nevertheless, weak. Pine Forest, with the railway embankment, gives an opportunity for a flanking fire, and if this weak point is the one we select for our attack, we have reached the stage where we must make our plan to wear down the enemy's resistance. How shall we do this?

By ordering a part of the detachment to attack the enemy's line and by maneuvering the reserves for the decisive stroke.

Here is one more important thing for every commander to remember:

The objective of the decisive attack should be struck unexpectedly and with the greatest possible strength.



Enlargment of section A outlined in the map below. This gives the answer to Question 6 of the third game

Plan of relieving outposts. Section B gives the answer to Question 7 of the third game

The Decision and Disposition of Colonel K

Colonel K and his staff are at the northwestern corner of Argus Farm. The artillery is in position to the right of the farm, two guns shelling the enemy near Railroad bridge. Communication with Captain C of the cavalry is established, and a Company of infantry is on its way to relieve the cavalry. This company serves also as Right Combat Patrol. A half Company is marching under cover to small woods on left flank as Left Combat Patrol. There are no signs of reinforcements for enemy.

Having estimated the situation, Colonel K makes the following decision:

"To attack the enemy along the lower portion of Timcum Creek, First Battalion the firing line. Direction, the bridge. Two Companies of Second Battalion as Artillery support on the edge of Pine Forest. Third Battalion reserve behind the center. Half Second Battalion and Fourth Battalion Detachment reserve behind the right flank on forest road."

Just as a steel spring upon being wound will set the mechanism of a clock into action, so these probably abrupt and, to the layman, somewhat ambiguous sounding orders from Colonel K will start the mechanism of this military machine into motion.

Imagine yourself there; accept the rôle of a Battalion or other commander on the field, and fully grasp the importance of these pictures given you. A moment like this, on the field of action, is a glorious one. The bloody shadows do not dull the eager and chivalrous desire of each soldier to match his own and his commander's skill against the enemy.

On the top of Lookout Hill four Battalions of Infantry, one Battery of Artillery, a Platoon of Engineers are in position. Only the first Battalion has thrown forward a skirmish line; the rest are in column, awaiting the moment of action.

On the edge of the woods the light skirmish fire of the cavalry and the enemy are pattering; now and then the boom of the enemy's cannon sends a thrill through the veins of the waiting troops. Officers, watchful, expectant, eager, await the beginning of the actual fight.

This was the picture up to the moment Colonel K made his disposition. Now the expectant attitude, the nervous standstill, is broken; cool energy and eager action have taken their place.

The Battalion commanders give their orders and, with the skirmish line moving toward the enemy, the different reserves go to their positions, and the picture now develops into an offensive combat.

These movements, told calmly and simply and expressed plainly on the map, are, in actual battle, difficult and full of danger—but danger is the spice of life for a soldier.

Colonel K's ambiguous sounding orders are translated as follows: The fact that he intends to attack the enemy along the lower shore of Timcum Creek is quite clear. For this purpose we see that he is using the first Battalion as a firing line.

Why not more?

For the reason that this one Battalion will hold the enemy's attention; it will keep the enemy, or parts of the enemy, in line, and will wear down its resistance.

Colonel K sends only this one unit to the firing line because he wants to hold the reins of action as long as possible in his own hands. For once a force is sent on the line it must remain there until victory has been achieved, or defeat suffered. To attempt to withdraw troops under fire would result only in disaster.

This is why Colonel K retained three fourths of his forces; he has, through this measure, insured a longer influence upon them.

Why did Colonel K say, "Direction, the bridge"? Everyone knew that the enemy was along the creek. What was the reason for indicating the bridge as direction?

The objective, the aim to be reached, is the important factor in the development of the attack, and must be clearly indicated.

The enemy commander as well as Colonel K, will use every means of covering his actions. He will make every use of the ground, and improve it by artificial means. The enemy, therefore, will not al-

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Hotels Built With a View to the Future

THE owner of a property in Los Angeles—a lot upon a very steep hill—is now reaping the reward of his good judgment in providing for changes that he felt certain were coming. He believed that a business street running on a stiff grade would have to be lowered sooner or later, and so when he built two large hotels of concrete and masonry, he provided for this contingency.

Hotel as it appeared prior to lowering of street level

Hotel as it appeared after the street level had been lowered, showing the conventional type store fronts

The buildings were provided with ground floors that were set about 16 feet below the level of the sidewalk. These were not mere basements but carefully planned quarters for business purposes, and for years these quarters have been awaiting the change in grade which has just taken place.

Broadway for a block or so leading to the North Broadway tunnel was cut down from a six to three per cent grade, involving a drop of 20 feet at the portal of the bore and a lowering of the tunnel; and before the hotels mentioned, the cut amounted to about 16 feet, the estimated distance when building was begun some years ago.

When the steam shovel began operations, it would have been necessary to make extensive changes in most structures: new foundations would be required, the underpinning of the walls would be needful and in general the rebuilding would be so extensive as to disarrange the business of the hotels and drive out the guests.

In this case, however, the work had been done in advance so skillfully that little alteration was required. When excavating began on the street, a trench before one of the hotels had been already dug and workmen were engaged in setting plate glass show windows in place and in surfacing the concrete walls which had been left rough, while they were below the surface. Then when the street and sidewalk were dug away by the steam shovel, the building was disclosed with a main floor added, and it was all ready for occupancy.

Motor-Driven Apple Grading Machine of High Capacity

AMONG recent labor-saving devices is an apple grading machine that has attracted much attention in the apple growing states.

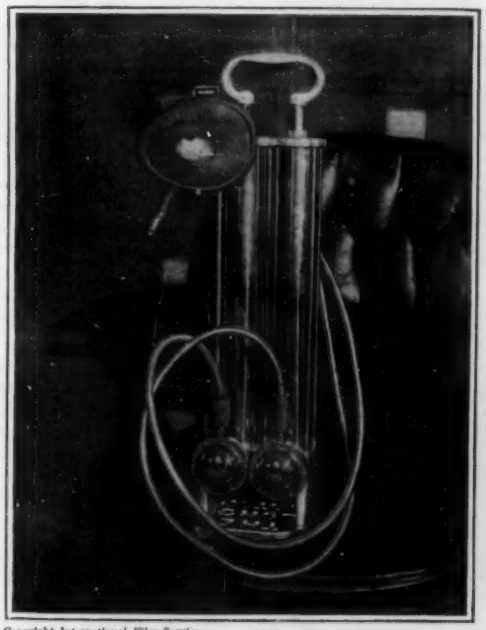
The new apple grading machine is operated by motor power and has a capacity varying from 40 to 60 barrels per hour, according to the size of the apples and the speed at which it is operated, the latter being variable to suit requirements. The apples can be graded in seven different sizes from 2¼ inches up to 4½ inches in diameter, each size varying one quarter of an inch. Although the machine is highly efficient in its work, its design and construction are of the most simple form possible. Briefly, the principle involved is that of an endless belt, with plates forming hollow squares which change their size on an ascending scale as they travel towards the end of the grader. The variation in the size of the squares is accomplished by the spreading of the belts.

With the use of the new apple grader, there is no possible chance for the apples to vary in size since the fruit can not fall through any hole until it reaches the proper size. With the old system employed in the roller grading machine the fruit could fall crosswise between the rollers and be carried to a wrong pocket. During the past season the new apple grader has been tried out and the results are said to have been most satisfactory.

Pumping Air Into the Lungs to Save Human Life

CLAIMING utmost simplicity and efficiency as its cardinal features, a device known as the Lungmotor and intended to stimulate natural, normal breathing in the resuscitation of victims of drowning, electric shock or asphyxiation, has recently made its appearance.

An apple grading machine which operates on the principle of spreading belts



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The Lungmotor—a device used for stimulating breathing in victims of drowning and asphyxiation

Showing the double-pump mechanism which is operated by a common handle, and the face mask with its connecting tubes. Because of its light weight, the device is readily portable.

The Lungmotor is unique in that it is little more than a form of double pump and its operation is not based essentially on the use of tanks of compressed oxygen. The two air pumps operate in unison since they are connected to a common handle. The construction is such, however, that there is no interchange of air between the pumps, so that at no time does the devitalized air come in contact with the fresh air or oxygen. The operation of the device is simple: an upward movement of the handle fills the pressure cylinder with air or oxygen—the latter if the small self-contained oxygen generator, which is included in the outfit, is employed—or a mixture of both, according to the setting of the air and oxygen valve. At the same time the suction cylinder fills with expired air, very gently drawn from the lungs of the subject. Conversely, the following downward movement of the handle and piston forces the air and oxygen, now contained in the pressure cylinder, into the lungs of the subject and discharges the expired air of the suction cylinder into the open. In many cases air alone is used with the Lungmotor, with satisfactory results.

In order to make the Lungmotor available for persons of all ages and corresponding varying lung capacities, it is provided with adjustments for different air volumes, suitable for new born, five-year-old, ten-year-old, fifteen-year-old, and small, average and large adults. This range provides for all sizes of subjects. The device does the very next thing to normal breathing because it supplies, mechanically, the tidal volume of air each respiration—a quantity of air equal to that which the patient would breathe while at rest, yet not so much as to possibly injure the lung tissues and the circulation, thus not leaving the patient liable to pneumonia following.

The Brooks Aqueduct of Canada

THE Brooks Aqueduct is, next to the great dam at Bassano, the most important engineering work in the Eastern Section of the Canadian Pacific Railway's Irrigation Block in Alberta. The Irrigation Block is divided into three sections, Western, Central and Eastern, each approximately 1,000,000 acres in area. The Western Section has been practically all settled, the Central Section has not yet been developed, while the work of colonization in the Eastern Section has just begun.

The water supply for irrigation purposes is obtained from the Bow River, but the Eastern and Western Sections are independent of each other, with separate intakes, the latter immediately adjoining the city of Calgary and the former near the town of Bassano, some 80 miles east of Calgary. About 4 miles from Bassano a great dam has been erected across the Bow River, which has raised the level of the river 46 feet and formed an enormous pool from which is diverted into the main canal the water required for the whole Eastern Section, which contains approximately 440,000 acres that either can now or will ultimately be irrigated.

The main canal leads away in an easterly direction for about 5 miles, and is then divided into two branches, going respectively north and east. The east branch, after having several smaller branches taken off, discharges the majority of its volume into an artificial reservoir that has been formed in a depression in the hills, and which is named Lake Newell reservoir. It has a storage capacity of 187,300 acre feet, or over 50,000,000,000 gallons, and is designed to be filled during the non-irrigating season.

A marked feature of the topography of this section is the existence of several deep valleys, one of which

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General view of the Brooks aqueduct in Alberta, which consists of a concrete flume 10,480 feet long

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel

ADJUSTABLE SHIRT SLEEVE.—P. THORMAN, 1027 Tremont Ave., Bronx, N. Y., N. Y. This invention provides means at the end of the cuff of a sleeve, whereby the ends can be elastically connected for the purpose of enabling the length of the sleeve to be adjusted, the cuff to be turned up so that the outside of the cuff will not become soiled, and whereby the sleeve can be adjusted to half length like the sleeve of an ordinary sport shirt.

FIRE HELMET.—J. A. TYCHON, 610 Cloquet Ave., Cloquet, Minn. The improvement relates more particularly to a helmet with means adapting the same to operate as a respirator in addition to the protection it affords the wearer. It provides an equipment, including an air intake box, which may be readily adjusted by the user to suit various conditions of use.

SHOE STRETCHING DEVICE.—W. B. CRANDELL, Mount Pleasant, Iowa. This inventor provides a device for softening and stretching the leather of a shoe at any point where the shoe may bind the foot of the wearer

SHOE STRETCHING DEVICE.

in order to relieve the pressure on the foot, the device employing means for primarily smoothing and tightening the leather to prevent its wrinkling or folding, and secondarily stretching the tightened area to the desired extent.

Electrical Devices

FASTENER FOR TELEPHONE TRANSMITTERS.—A. J. GATTERMEIR, Box 276, California, Mo. The object here is to enable the transmitter to be removed or replaced in a fraction of the time usually involved by the use of screws; to enable the transmitter to be removed without the use of a screw driver or other special tools; to prevent annoyance and loss of time due to the loss, breaking or wearing of screws and like fasteners, and to provide a very neat fastening means so as to give the transmitter an improved appearance.

Of Interest to Farmers

YIELDING MOUNT FOR PLOWS AND OTHER TOOLS.—E. DUNLAP, Box 23, Diamond Spring, Cal. This invention provides a mount for plows and other tools, which will permit the plow or other tool to pass over an obstruction, such as a stump or rock, and still make it impossible for the plow or other tool to be drawn out of line when passing through an obstruction of less resistance, such as a hard spot in the soil.

BEAN HARVESTER.—F. H. QUANCE, Crosswell, Mich. The invention provides means for cutting off the stalks at any desired distance above the ground, delivering the same to a receptacle therefor, and when desired, removing the stalks so delivered from said receptacle, all the parts being carried upon a pair of wheels, the revolution of which actuates the mechanism when such actuation is desired.

NEEDLE AND GUARD THEREFOR.—A. L. POWELL, Alamo, Tenn. This invention relates to grain harvesters and binders. It provides a needle and guard therefor, arranged to permit of using a needle without a crank arm, and thus allow of swinging the needle downward without danger of striking the ground, the needle guard serving to cut off the loose grain from the needle and to prevent it from passing in behind the needle and clogging the movement thereof.

Of General Interest

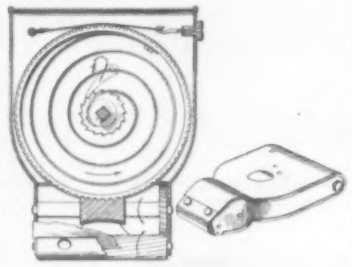
ROOF COLLAR.—O. M. REDLOS, 181 Front St., Bath, Maine. In this case the invention relates to a collar to be placed on a roof around a vent-pipe, or the like, and arranged to secure the flashing. An object of the invention is to provide a collar having a wide range of adjustment to conform to the particular pitch of a roof.

OVERSHOE FOR HORSES.—MABEL BLACKMAN, 204 W. 82nd St., New York, N. Y. This invention provides an overshoe with removable wearing members and a rigid sole plate partially covering said wearing members; provides means for readily attaching and detaching the shoe; and provides means for preventing rattling or jamming of the parts of the shoe.

Hardware and Tools

MACHINE FOR REMOVING GRASS.—C. W. HEARLEY, Grangeville, Idaho. This invention is an improvement in machines for removing grass, and the object is to provide mechanism in the form of a cutting disk, for cutting the grass below the surface of the ground and for lifting the cut grass and soil, and delivering it to separating mechanism.

RAZOR.—W. A. FUSCH, Room 8, Stine Bld'g, Decatur, Ill. This invention relates especially to that class of razors in which a motor is employed, and has for its object to simplify the present method of shaving or removing the



RAZOR.

beard from the face, avoiding the necessity of lathering the face, etc, as is required by the present type of razors: another object is to produce a small and compact device that may be carried in a vest pocket, and one which does not require sharpening, being self-sharpening.

OIL WELL DRILL.—W. S. LAWS, Cushing, Cal. One of the principal objects of the improvement is to provide a drill with means for preventing the drill bit from loosening in the well, said means adapted to act as a core or lock whereby the drill stem and jar may be raised from the well should they become broken.

Heating and Lighting

DETACHABLE COUPLING FOR ELECTRIC FIXTURES.—J. M. CRUCET and M. H. GOLDSMITH. Address the former, care of Crucet Mfg. Co., 256 W. 28th St., New York, N. Y. This invention provides a detachable coupling and system of wiring for electric fixtures or a device for attaching and detaching brass or other electric fixtures to all styles of portables, electroliers and hanging electric light fixtures, whether of wood, metal, china, glass, composition, fiber or any material used for such portables, electroliers or fixtures, whereby a fixture having any number of light sockets can be employed without rewiring the portable, electrolier or fixture.

Household Utilities

AUTOMATIC DRIP COFFEE POT.—O. W. CHAMBERLAIN, 2014 State St., New Orleans, La. This invention provides a construction wherein the water is designed to pass through the coffee grounds but once. It provides a construction of coffee pot wherein the made or completed coffee is maintained normally without in any way coming in contact with the grounds.

ADJUSTABLE SWATTER.—A. V. KELLY, 507 Park Place, Brooklyn, N. Y., N. Y. This improvement relates particularly to an adjustable swatter for use in killing flies, mosquitoes and the like either on the ceiling of a

ADJUSTABLE SWATTER.

room or on the walls. When used on the ceiling it will strike the same in a flat condition or when used on the wall will strike the wall in a flat condition, and thereby kill the fly or mosquito without injuring the wall.

Machines and Mechanical Devices

PILE EXTRACTING MECHANISM.—A. R. CUTHBERTSON, Turners Falls, Mass. This invention relates to a mechanism for extracting or withdrawing piles, sheeting, and the like. It also provides such a mechanism whereby a continuous and an intermittent pulling force may be applied simultaneously to the pile or sheeting whereby to withdraw the same.

THREAD CUTTING ATTACHMENT.—C. W. CARMAN, care of Empire State Bag Co., 760 Wythe Ave., Brooklyn, N. Y., N. Y. The invention provides an attachment for a sewing machine, arranged adjacent the path of travel of the material being sewed, so that the operator may cause the same to be severed by a slight turn of the thread connecting a series of articles; provides means for severing a continuous thread uniting the articles manufactured in chain form; and provides a mechanism for employment in types of sewing machines known as factory machines.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

The Brooks Aqueduct of Canada

(*Concluded from page 385*)

is situated just east of the reservoir. It is about 2 miles in width, and to cross it an aqueduct has been constructed; an aqueduct being chosen, after some consideration, in preference to a siphon—a type of structure which has been used elsewhere in the irrigation block.

The aqueduct is supplied by a short canal from the reservoir. It consists of a reinforced concrete flume 10,480 feet in length, having a curved cross section, about 23 feet in width at the top, and nearly 9 feet in depth from the top full-flow water level to the center of the curve at the bottom. This will carry water for the irrigation of 125,000 acres of land, and its discharge capacity is 900 cubic feet per second. The eastern end is between 4 and 5 feet lower than the western end, causing a grade for the water flow.

The flume, which is 5 inches in thickness, is suspended between horizontal girders, the whole being supported by a reinforced concrete trestle made up of two lines of columns which vary in height according to the contour of the valley. The maximum height is 60 feet.

At about 3 miles east of the town of Brooks, the site of the aqueduct is crossed by the main line of the Canadian Pacific Railway. The track is at such an elevation that sufficient room for the flume overhead could not be found. A siphon under the track was therefore necessary. At the west side of the track the curved form of the flume is continued round until a completely circular pipe is made, which dips at an angle of about 45 degrees and enters the ground, which it traverses under the rails at a slight depth for a distance of about 55 feet, when it rises again to the original level and reverts to the original form. This siphon is 9 feet 9 inches in diameter at the smallest and 12 feet 8½ inches at the largest.

War Game—IV

(*Concluded from page 384*)

ways pose for us, in order to give us a chance to take careful aim. There is another reason for such an order: the attack should be concentrated on a certain point to assure decisive success for the offensive.

When Colonel K gave the "direction" as the bridge, it meant that the space of action for this First Battalion was reduced to a limited front on the field of action.

The necessity of the support for the Artillery is so clear that it needs no special discussion.

The reserve behind the center is, to use a striking simile, the cards with which we play the game, to gradually bring forward the line of attack. While the reserve behind the right flank is the highest trump, which, if played out in the right place and moment, will bring about the final results.

Questions

Question 1. Considering Colonel K's order, formulate an order as though you were the commander of the First Battalion.

Question 2. Captain C receives the order to lead the covering detachment to relieve the Cavalry. How will he proceed? What will be his chief aim as Flank Guard?

Question 3. Make an enlargement of the field of action on a scale of 6 inches to a mile. Draw or mark in with pins the position when the First Battalion opens fire. Locate the reserves, Artillery, its support.

The Defensive Combat

The stronger man is not always the offender, nor is the stronger general always on the offensive. Back of all successful defensive operations must lie the spirit which watches for the opportunity to take the offensive to deliver a crushing blow when and where it is least expected, and with the greatest possible force.

The chief advantage of the defensive is the chance to hold a numerically superior force at bay, to wear this enemy down during its approach and fire combat by a deadly and accurate fire. And, finally, when through the wearing power of a withering fire, the balance of power begins to lean toward the defender, to take the offensive and strike hard.

In our case the numerical superiority of Colonel K's detachment is evident. He has one Battalion and a platoon of Engineers, more troops, as well as a superiority of the Cavalry, at his disposal. He feels himself the stronger, and he has the conviction that, through an offensive, he will accomplish the task of securing the bridges across the Nehaminy River above Pottstown.

We will now join the enemy forces and consider their problems.

Lieutenant-Colonel LC, on Chester Hill, close to the railroad, commander of the invading force, has many difficulties to overcome in regard to the land, topography, etc.

He has, however, a great deal of information concerning the strength, the composition and the mission of Colonel K's detachment. Furthermore, he is in signal communication with a patrol on Paoli Hill, which informs him that at 10:30 A.M. strong enemy forces were nearing Norrisville from the south. A staff officer arrives at 10:50 A.M. from the north, with a message that a regiment of cavalry is at that moment passing Greenville to reinforce Colonel LC's detachment.

At this moment the combat is already in its first stage.

Lieutenant-Colonel LC receives orders from his headquarters to hold Timcum Creek line till 4 P.M., and if enemy is not shaken then to retire toward Greenville. Considering the perspective, which shows the layout of the country very clearly, and the developments of the battle at 11:30 A.M., and also making a study of the map to find an advantageous point for the counter offensive, we shall consider the following questions:

Question 4. How much force will Lieutenant-Colonel LC put in the firing line?

Question 5. Where will he place his reserve?

Consider here the point which will become the center of the offensive action.

Question 6. Where will the Artillery be located? And why?

These questions will be answered in the next issue of the SCIENTIFIC AMERICAN.

* * * * *

Answers to Questions in War Game III

Question 1. See map where route of returning outpost is marked.

Question 2. The order given by the commander of the outpost Battalion would be as follows:

"The enemy is advancing on Pottstown. Our detachment shall march immediately to Pottstown.

"The outpost is relieved. It will assemble at Railroad bridge and take its place in rear of column.

"One platoon from D Company rear guard.

"I shall be near bridge."

Question 3. The bridge was blown up.

Question 4. Under the circumstances, the advantages offered by the occupancy of the hill across the river demand that the Detachment commander exert every effort to secure and hold same.

Question 5. The Battalion, after disembarking from train, is still over two miles away from top of Lookout Hill. This means a march in the direction of the enemy. Therefore, the first action must be to take security measures by sending out an advance guard.

For the time being, the Battalion is a detachment and must act as such. However, the nearness of the enemy makes it imperative that the advance be made with great caution, and to this end a forward movement in line, after the passing of the bridges, will insure greater security, especially if small patrols are moving ahead, searching out the territory.

According to this, the Battalion will cross the bridges with an advance guard and, once on the right shore, will take up line formation. Of course, combat pa-

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trols as Flank Guards are automatically placed.

Question 6. See diagram.

Question 7. See diagram.

Occurrences of Importance

Colonel K's detachment has advanced 1,000 yards toward the defensive line at Timcum Creek.

To simplify matters, we shall call Colonel K's detachment from now on "the Blues," and the enemy, coming from the north, "the Reds."

The Reds have developed a withering fire, and with the effective work of their Artillery on Chester Hill, forced the Blues to slow advances. However, on their right flank, under cover of Pine Forest, they push forward to 500 yards' distance and, with the reserves, are getting ready to make another rush before attempting the assault on the Red's left flank.

At this moment orders are received from Colonel K, who directs the combat from Argus Farm, to hold the edge of the forest and not to attempt the assault.

At 1 o'clock the deft flank guard receives the attack of two squadrons of Red cavalry from Lebanon Forest, and is swept away.

At this time Red reserves are thrown into the line on Timcum Creek and their Artillery directs a furious fire on the center of the Blues.

* * * * * *

The further developments of the combat will be worked out in War Game V.

The Extreme Ranges of Modern Guns

(Concluded from page 379)

the smooth progress of the modern projectile with its pointed head, and that of a projectile with a perfectly flat head. The relatively huge bow wave of the latter is to be noted as well as the wave preceding it. The two figures illustrate well the advantage of a projectile with fine lines; and the comparison is like that of a scow with a racing yacht.

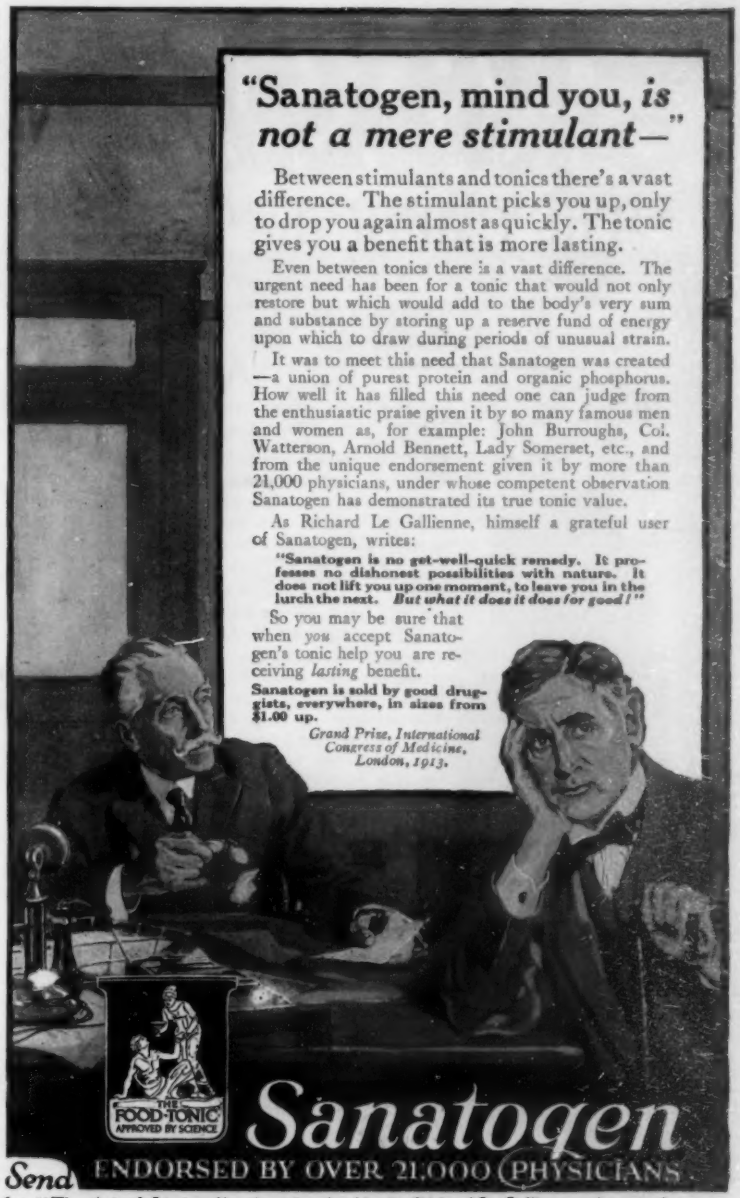
The head shown in Fig. 2 offers but two thirds of the resistance incident to the use of a head like that shown in Fig. 1, while that in Fig. 3 offers but one third of that shown in Fig. 1 and but one half of that shown in Fig. 2. It is at once seen that the resistance has been reduced to one third of its original magnitude by actual improvement in the shape of the point alone. The reason for this is that the rifling of the gun causes the projectile to spin around its axis like a top; and this action causes it to present its head alone to the air.

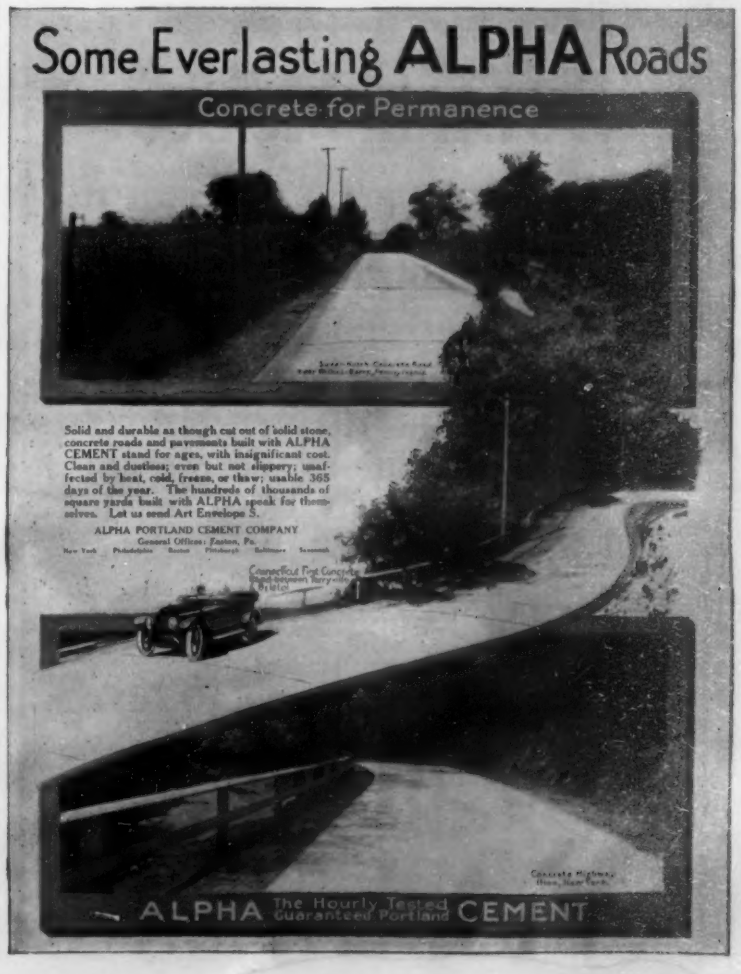
Air resistance is proportional to the density of the air, and if the density of the air is diminished, the resistance of the air is proportionately reduced. Due to great increase in muzzle velocities and to the reduction of the resistance of the air by improvement in the form of the projectile, it is now possible with large angular elevations to throw the projectile to very great heights as it describes its trajectory. The air, as is well known, becomes rarer as the height above the earth's surface increases. More than half of the entire atmosphere lies below a height of 4 miles, and nine tenths of it within 10 miles. Calculation shows that when, in describing its trajectory a projectile ascends to a maximum height of 6 miles, the average air resistance in the trajectory is reduced one half, and that when the maximum height is 12 miles the average air resistance in the trajectory is only one fourth of what it is at the surface of the earth.

For such an extreme trajectory as one with a maximum height of 12 miles the mean resistance is therefore only about one tenth part of what it would have been for a projectile of the old pattern shown in Fig. 1 with a flat trajectory. Modern construction has made possible a trajectory in which the resistance no longer precludes a close approach to the trajectory of unresisted motion.

The conditions of attainment of such ranges are exceptional; and for other elevations and lower velocities, such as are usual in practice, the range in air is seldom more than half of that for unresisted motion with the same elevation and muzzle velocity.

There are several reasons for not at-





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tempting to realize in practice the full ranging possibilities referred to above. In the first place, what is called *erosion* is a great obstacle to the practical attainment of very high velocities. Erosion consists in the wearing away of the rifling of the gun due to the great amount of heat and the high pressures inseparable from the attainment of great velocities. Erosion is more troublesome in large guns than in small ones. Even with velocities in common use, guns are often relined, or have the interior of the gun renewed; and this is a process which consumes time. It is to be expected, however, that science will eventually find a remedy or even a preventive for this troublesome disease of guns.

A second consideration limiting the practical ranges of guns lies in the fact that at sea and on the seacoast, where the largest and most powerful guns are used, the curvature of the earth actually hides the enemy at extreme ranges, such as those referred to above. The scattering of the shots at such ranges would make the chance of hitting far less than one in a hundred.

Elevations of 30 deg. with muzzle velocities of between 2,000 and 3,000 feet per second are, however, consistent with present practice, the object being to at least equal the ranging power of the enemy.

The bombardment of a distant city from a position on land would justify the employment of any gun at its maximum range. Here the target is sufficiently large to receive a majority of the shots. This explains the fall within the city of Dunquerque of shots fired from a point 21 miles away.

Below are given the values of the curvature of the earth in feet for a number of different ranges:

Range, miles.	Curvature, feet.	Range, miles.	Curvature, feet.
5	17	30	600
10	67	35	817
15	150	40	1,067
20	267	45	1,350
25	417	50	1,667

Thus at 20 miles, it would be difficult to see even the top of a ship's mast from ordinary heights on shore and the ships would have the same difficulty in seeing their targets, whether the latter be ships or forts.

That very great ranges in air are practicable for various velocities and projectiles may be seen from the following:

Gun.	Ranges in miles.			
Velocity	2,600	2,800	3,000	3,200
10-inch	24	27	30	35
16-inch	27	31	37	43
Gun.	**Ranges in miles.**			
Velocity	**3,400**	**3,600**	**3,800**	**4,000**
10-inch	40	47	54	63
16-inch	51	60	71	85

The greatest heights to which the projectiles ascend are:

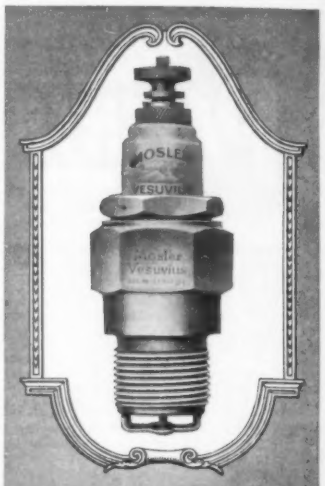
Gun.	Heights in miles.			
Velocity	2,600	2,800	3,000	3,200
10-inch	7	8	10	12
16-inch	8	9	11	13
Gun.	**Heights in miles.**			
Velocity	**3,400**	**3,600**	**3,800**	**4,000**
10-inch	14	16	18	20
16-inch	15	17	19	22

From these figures it is seen that firing 21 miles as from Nieuport into Dunquerque is feasible with a 10-inch gun with a projectile weighing 550 pounds and a muzzle velocity of 2,450 feet per second, while a 16-inch gun could perform the same feat, using a projectile weighing a ton, and with a muzzle velocity of only 2,250 feet per second. These weights of projectile and muzzle velocities are in common use to-day, and the muzzle velocities are rather below than above the average requirements of the present.

In the same way it is seen that firing across the English Channel is entirely feasible, with a suitable gun and mount.

By the use of lighter projectiles, greater velocities are attainable in the same gun, and a range of 35 miles with an elevation of 45 deg. is entirely possible with the most powerful guns in use in the world to-day.

On the other hand, guns made for the mere purpose of attaining velocity and range and without regard to the continued effectiveness of the gun or the explosive power of the projectile, may attain almost any range within the limits of unresisted motion for the velocity used. Such guns would, at the present time, be "freaks"; they would be speedily



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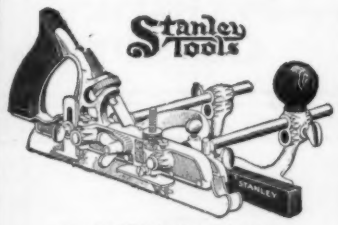

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worn out by erosion, and the light projectiles would have small explosive effect.

The extreme ranges tabulated for trajectories in air are of interest not only as showing what is already *possible*, but as indicating that in future they may become practicable and usual. It is entirely possible that erosion may eventually be greatly reduced or even obviated, and indications are that the form of projectiles will be still further improved. The strides of the last half century in gun construction have been more remarkable than would be the steps now suggested as possible.

It is not extravagant, then, to assume that, at the proper time, these extreme ranges will be realized without undue sacrifice of the effectiveness of gun or projectile.

Conveying and Applying Concrete by Steam

(*Concluded from page 379*)

irregular. The small size of the tunnels would have made the use of ordinary forms inconvenient. Hand work would have been difficult because of the unevenness of the surface. Apprehensions were entertained even as to the steam method. It was thought that the heat and the exhaust steam would create difficulty in the small space. However, a steam boiler was brought into use on the surface and the combined mixer atomizer added to the surface equipment. A rubber hose conveyed the concrete down into the tunnel and to the point of use. No especial difficulty developed and the work was successfully carried out, the distance of transmission running up at times to several hundred feet. The same railroad has used the steam method in repairing disintegrated places on concrete retaining walls. The chisel was employed to clear away defective concrete. No trouble was experienced in putting concrete onto these vertical surfaces. Here we have what appears to be a very considerable advantage. Forms may often be dispensed with in vertical work and even in overhead applications. The New York Central Railway utilized this procedure quite recently in giving a white coating to certain parts of the concrete substructure of the great Grand Central Terminal in New York City. Here it was not a question of concrete but a Portland cement mortar consisting of one part cement and three parts crushed marble. The mortar was sprayed on in two or more coatings of about ⅛ inch each.

A more considerable piece of work was done by the Chicago and Great Western Railway in the restoration of an old tunnel half a mile long. The bore passes through rather unstable material containing more or less water. Originally, wooden timbering had been used. Later on a brick lining was put in place inside of this. The cross-section available for use was in this way cut down to just about the limit. A great deal of disintegration took place with the passage of time, this disintegration arising in part from freezing and thawing. In short, it became imperative to restore the stability of the construction, especially in the roof. It was highly desirable too not to take the tunnel out of service. All the conditions conspired to make this a most difficult problem.

The steam method was applied, but this time upon a movable construction train which could be run in and out of the tunnel at a moment's notice. A flat car just back of the tender provided for the machine. Steam came from the locomotive. The transmission line was carried back onto a second car. Here a platform 20 feet long and 4 feet high supported a track on which a carriage could be shifted a distance of 10 feet by a hand-operated windlass and rope. On the carriage a nozzle holder was set up. This was movable in such way that the nozzle could be swung through an arc lying in a transverse plane. The holder was swung by means of a small steam engine. The transmission line was flexibly connected with the nozzle. There was a box car to the rear which was utilized to support a platform and railing for the men cleaning the surface preparatory to the application of the concrete. The whole train could readily be shifted by the locomotive, the nozzle longitudinally by the windlass and

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Patriotism

Do you stand for Patriotism?

If you do, you will be interested to know that THE OUTLOOK has just issued a little four-page circular containing a brief address on Patriotism by Lyman Abbott, "The Salute to the Flag," and several stanzas of "America" and the "Star Spangled Banner."

This leaflet is intended for general distribution among the people of the United States in an endeavor to stimulate their enthusiasm and interest in their country, its present welfare and its future. It may be used in the schools, in the churches, inserted in your daily mail, given to your friends,—in any way that will serve to bring it to the attention of the American public.

A pound package containing about 250 will be sent upon request, postage prepaid, to anyone upon receipt of twenty-five cents to cover the actual cost. Single copies free on post-card request.

Orders should be sent, with remittance, to Arthur M. Morse, Assistant Treasurer, 381 Fourth Avenue, New York City.

Cave Life or Civilization

Civilized man is distinguished from the cave man by his habit of co-operation.

The cave man lived for and by himself; independent of others, but always in danger from natural laws.

To the extent that we assist one another, dividing up the tasks, we increase our capacity for production, and attain the advantages of civilization.

We may sometimes disregard our dependence on others. But suppose the farmer, for example, undertook to live strictly by his own efforts. He might eke out an existence, but it would not be a civilized existence nor would it satisfy him.

He needs better food and clothes and shelter and implements than he could provide unassisted. He requires a market for his surplus products, and the means of transportation and exchange.

He should not forget who makes his clothes, his shoes, his tools, his vehicles and his tableware, or who mines his metals, or who provides his pepper and salt, his books and papers, or who furnishes the ready means of transportation and exchange whereby his myriad wants are supplied.

Neither should he forget that the more he assists others the more they can assist him.

Take the telephone specialists of the Bell System: the more efficient they are, the more effectively the farmer and every other human factor of civilization can provide for their own needs and comforts.

Or take our government, entrusted with the task of regulating, controlling and protecting a hundred million people. It is to the advantage of everyone that the government shall be so efficient in its special task that all of us may perform our duties under the most favorable conditions. Interdependence means civilized existence.

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the nozzle laterally by the little steam engine. One setting of the train permitted application of concrete to some 100 square feet of surface. The concrete was made on the formula 1:3:2, the coarse aggregate consisting of pebbles.

When spraying begins, some of the coarser material will not adhere, the layer of cement being at the moment insufficient in thickness. But these coarser pieces are thought to perform a very useful service by battering the finer material into the surface. As the coating gets thicker, larger and larger pieces adhere. Those which fall off may be recovered and used again.

Wood Waste

(*Concluded from page* 383)

inches square, often larger. All were sold as kindling from the plant at, perhaps, one sixth of the cost price, or used in the plant itself as a fuel, whose value was from one third to one half that of low-grade bituminous. It has been carefully proved that wood waste in the wood-using plant is seldom less than 19 per cent of all material purchased; it is often as high as 30 per cent. But in the factory, wood waste, for most practical purposes, stops. Indeed, there is little more to waste, though in different parts of the country there are some special wastes—as in the early turpentine orchards, where improper "boxing" is said to have ruined for commercial purposes one fifth of the forests worked; and the tanbark operations which continued for many years in hemlock, operations where the bark was all carefully peeled and taken, and the trees were left.

Waste as a Whole, and Its Effect

Wood left in the forest, from branches, tops, chips, stumps, and sawdust, was fully one third of the tree; the mill took one third of the log as sawdust, slabs, and trimmings; the factory one fifth of the board as sawdust, seasoning, shavings, edgings, and defects. Practically 35 per cent of the tree will appear in the finished product. This proportion may vary with States; it does not differ much for the country.

We could better afford it if this were all, but in the forests where this material had its source, there is, perhaps, no provision for another crop; at best, one markedly inferior. The land, if in the hills or mountains, is probably abandoned with little effort toward its improvement through cultivation. The cost of floods has never been really worked out, though now and then, as recently in Illinois, comes an account of one which does a million dollars' estimated damage, destroys railroads and buildings, a few lives, and inundates perhaps a hundred thousand acres of rich farm land. Probably $50,000,000 to $75,000,000 is being lost to this country annually through the poor use or absolute disuse of millions of acres of cut-over lands profitable only for the growing of trees. There are now some 16,600 square miles of land, 0.6 per cent of the country's total area, once fertile enough, but at present in abandoned farms, 6,100 square miles of which, after unskillful cultivation and final abandonment, had further to be ruined through soil erosion.

The wastes of factory and mill affect us most directly in a financial sense; those of the forest, so long as forests are reckoned an attribute of successful national management and welfare, must be long-reaching in their benefits or injuries. Small blame attaches to the lumberman. He has been an instrument throughout of trade necessities and economic situations.

Lights His Pipe Electrically.— William H. Fulton, of New York city, in a patent 1157771, describes the defects in the ordinary tobacco smoking pipe resulting from the distillation of the moisture on account of the air being drawn down through the unburnt portion of the tobacco and claims this will be avoided by igniting the tobacco initially at the bottom of the bowl. To do this he provides at the base of the pipe bowl an electric conductor which is energized by a plug connected up to an electric lamp socket so that as the pipe is being lighted the lamp filament will glow to indicate when the tobacco igniting conductor is operating.

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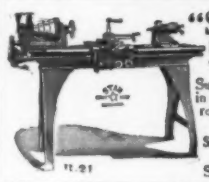

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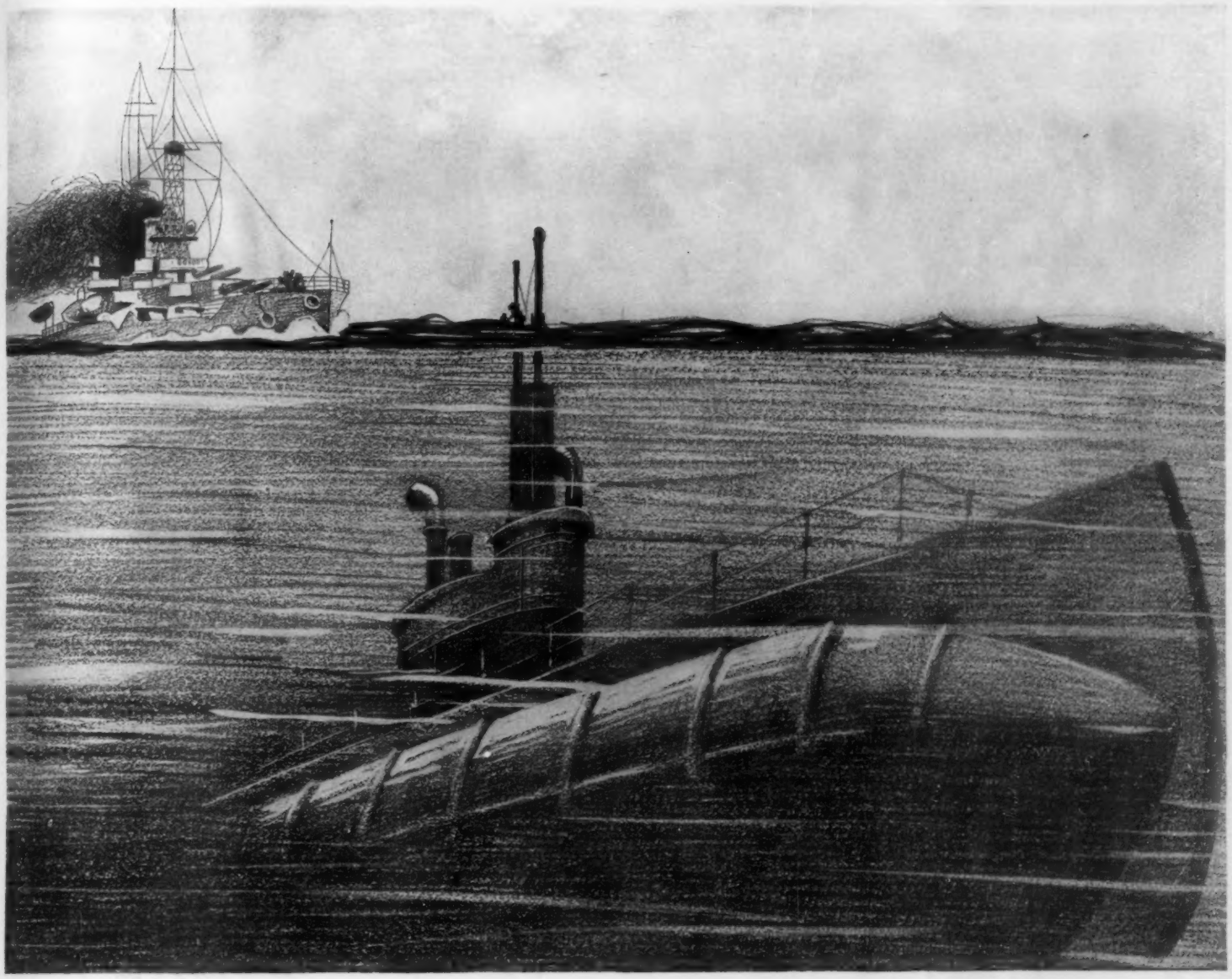

He Invented the Periscope—A Fortune Was His—Then—

What all the naval experts of the world could not devise, this "rolling stone" invented. Then, though his invention was a success, though no one else had attempted such a device, Fate stepped in to rob him of it. His dream of wealth was shattered!

MORGAN ROBERTSON proved that truth was far stranger than fiction when he wrote for the Saturday Evening Post the story of his own life. Take, for instance, his inventive side. No one has written a romance of industry that compares with Robertson's experiences in inventing the periscope.

Robertson had gone to visit a naval officer, to secure material for a sea-story. The officer took him on board a submarine.

Let the sailor-author continue the story:

"While in the lower part of the little boat the lieutenant in command showed me all its workings. It was a great day for me.

"'The one thing we need,' he said as we came up, 'is an apparatus by which we can see what is going on above without having to rise.'

"'In other words,' I added, 'if you could look into a glass down below, and, by a series of reflections, be able to view the surrounding surface of the water above, it would then make the submarine the most powerful of battleships.'

"'Exactly.'

"'Then I am going to invent it,' I declared; and I left him, knowing absolutely that it could be done.

"At that very moment, though I did not know it, a Frenchman, seated at his desk in Paris, was innocently devising a fantastic yarn that was destined to deal me a crushing blow—from which I never recovered.

"It was at the expiration of a year of experimenting I suddenly discovered that, in addition to other lenses, a cone-shaped glass placed in the end of the tube would do the trick of refracting the light rays as I wanted them. I was beside myself with joy. Working night and day I quickly rigged out a model, and—imagine my delight, it worked! I had solved the problem! I had invented the periscope!

"I sat across the desk from the lieutenant as he unrolled my blue-prints, and I shall never forget the expression in his eyes when he looked at the first one.

"'You've got it!' he declared exultantly. 'The cone-shaped tip solves the problem. I congratulate you.'

"I told him I had applied for a patent.

"The lieutenant suggested to me that if I could live on fifty dollars a week his company would put me on the payroll so that I might continue my experiments.

"It was in the midst of these happy moments that the blow fell. And this brings me back to the Frenchman and his yarn.

"The lawyers notified me that the United States Government had refused to grant me a patent on the periscope because a story had been published, prior to my application, in a French magazine, which had described fantastically the possibilities of an instrument similar to the one I had invented.

"My hopes were blasted. Understand, this Frenchman did not attempt an invention. He merely wrote that it was possible.

"My beloved periscope was now public property, and anybody had the right to proceed with its development. Though the submarine boat people had treated me generously, my devices were no longer needed. I was out of a job. Really, I believe it was the saddest moment of my life when I went back to the typewriter and began to lay out a story. Ahead of me I saw the old grind, the weary rounds of the magazine offices, the butcher, the grocer, the landlord, and the wolf!"

MAKING A DREAM COME TRUE

You think this story tragic. Robertson's life was full of such tragedies. Though he wrote stories that such magazines as McClure's, Saturday Evening Post, Harper's, etc., eagerly accepted, he died poor, and left his frail little wife without an income. It was these facts that led to the McClure-Metropolitan movement to gain him recognition and reward. His desire, when dying, was that the sale of his books would permit his devoted wife to live without want. Will the American public grant him his last wish? That's what we propose to find out. YOU answer YES when you send for this new four volume edition of Morgan Robertson's Works, together with a year's subscription to McClure's Magazine, Metropolitan, and The Ladies' World. WE will pay for the books. WE will pay the carriage charges on them. WE will pay Mrs. Robertson a generous royalty—if you will pay for the magazines less than they would cost you at the newsstands, and you may pay for your subscriptions in easy monthly payments.

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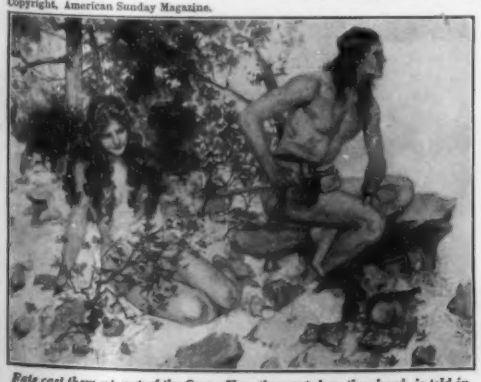

Fate cast them up out of the Sea. How they met, how they loved, is told in "The Three Laws and the Golden Rule," included in this Set.

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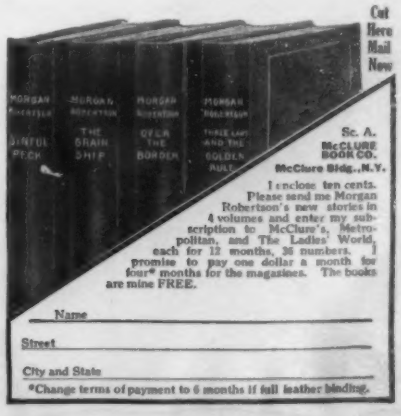

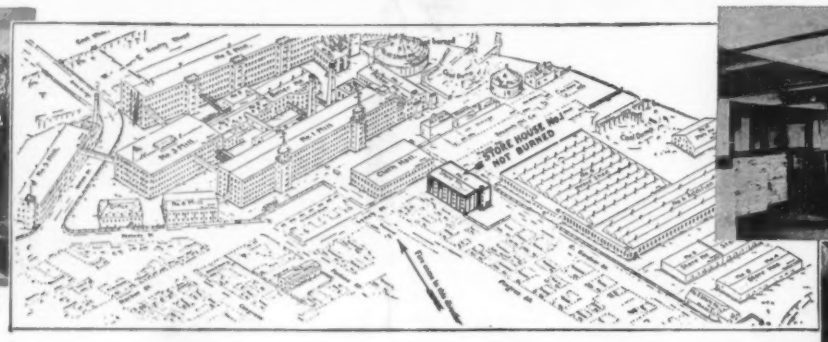

Salem, Mass., fire, June 25, 1914. Map showing plant of Naumkeag Steam Cotton Co. which was entirely destroyed with the exception of Storehouse No. 1, a reinforced concrete building, and Storehouse No. 10. The picture on the left shows Storehouse No. 1 surrounded by the ruins of other buildings. On the right, upper, the interior with contents unharmed; lower, wired glass window melted by the heat and interior shutter scorched by flames.

Concrete Buildings Protect Against Fire

WHEN the great Salem, Mass., fire destroyed in thirteen hours sixteen hundred buildings, valued at over fourteen millions of dollars, the destruction of the great plant of The Naumkeag Steam Cotton Company was the heaviest individual loss. Of all the buildings of this enormous plant only two escaped destruction, and of these Storehouse No. 1, which was in the direct path of the flames, was practically uninjured.

In a complete report of the disaster issued by the National Fire Protection Association, Boston, Mass., President Franklin H. Wentworth says:

> "The only buildings in the entire plant that escaped destruction were No. 10 Storehouse and No. 1 Storehouse . . . . . No. 1 Storehouse is of reinforced concrete construction, walls, roof and floors. There are some small wired glass windows in metal sash, mostly fixed, which are protected in addition by wood tin-clad shutters on the inside of the building, hinged at the top and swinging vertically, and these were held open normally by fusible links. These links all melted and allowed the shutters to close. Two stories of this building contained finished goods in cases, but although the building was exposed to the full force of the conflagration on the west side, so completely did the window protection do its work, and so well did concrete walls stand up against the flame that fire did not enter the building. Not a sprinkler opened, and the contents are intact. The damage to the building is so slight as to be almost negligible, and while the wired glass windows in several cases suffered so much heat that they softened and bulged out at places, and in one case completely melted out, yet the interior shutters withstood the attack, and did not allow the fire to enter the building."

THOMAS A. EDISON said: "*All permanent buildings which I shall erect in the future will be built of concrete, as the results of our fire are a triumph for this material.*"

The burning of the Edison plant at Orange, New Jersey, Dec. 9, 1914, offers again a remarkable testimonial to the fire-resisting qualities of concrete. Due to the tons of celluloid, wax, lumber and other highly inflammable materials in the buildings the intensity of the fire was so great that copper melted, iron fused, and the glass melted from the window openings. In fact, it was estimated by a committee of men of high professional standing that temperatures in excess of 2500 degrees F. were reached. Six wood, brick and steel buildings were entirely destroyed and the contents of seven concrete buildings swept out by the flames. But when the fire had finally spent itself the seven concrete structures with walls and floor slabs intact, stood amid the ruins of buildings of other types of construction.

Thomas A. Edison, Inc., fire, West Orange, N. J., Dec. 9, 1914, showing how concrete buildings withstood the conflagration.

A statement made by the officers of the Thomas A. Edison Co., says:
"The salvage in machinery in the reinforced concrete buildings will be at least 94%; of the buildings 87%; cost of restoration of these buildings from 10% to 15%."

A 224-page illustrated book—**"Factories and Warehouses of Concrete"**—will be sent free of charge to prospective builders of factories and warehouses who write to us on their letterheads. We will also send on request a copy of an authoritative report on the Edison fire.

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SCIENTIFIC AMERICAN

RUSSIAN INFANTRY MAKING USE OF MOVABLE STEEL SHIELDS DURING AN ATTACK.—[See page 407]

April 15, 1916

Munn & Co., Inc., Publishers
New York, N. Y.

Price 10 Cents

A STATEMENT

Concerning Final Drive in White Motor Trucks

IN VIEW of the conflicting claims for this form and that form of final drive which now confront the purchaser of heavy duty trucks, this Company, as the largest manufacturer of motor trucks in America, deems it fitting to make a public statement of its own purpose and practice in the matter.

White Trucks of over two tons capacity have always been chain-driven, and *will continue to be chain-driven* until some other form of final drive is developed in the future which is more efficient or equally efficient. In its present stage of development, worm drive will not be adopted by this Company, and White engineers now see no prospect of its basic handicaps ever being sufficiently overcome to warrant its adoption.

CHAIN DRIVE EFFICIENCY

1. White chain-driven trucks are more efficient because more power is delivered to the rear wheels.
2. They require a smaller motor for equal load capacity.
3. They consume less gasoline, getting as high as 50% more mileage per gallon.
4. They endure a higher road speed; perform more easily on rough roads, steep grades, and in heavy going.
5. They pull loads out of chuck holes and over obstructions which would stall a worm-driven truck.
6. Tire mileage is materially greater because the unsprung weight on the wheels is so much less.

WHITE TRUCK PERFORMANCE

Motor trucks have been in use long enough to accumulate a volume of motor truck experience, long enough for owners to know *actual operating value*. They can compare one truck with another. They have the records of performance; and large users who keep the most effective cost records indicate the showing of those records by an overwhelming preference for White Trucks.

That preference is well known. It is eloquently reflected in the fact that in total annual sales White Trucks predominate two to one of any other make, and among many large users they predominate ten to one.

WHITE TRUCK PREDOMINANCE

When a truck both outsells any competitor two to one and commands a higher price—its competition is severely felt by trucks of similar design, so severely in fact, as to necessitate a change in that design to escape the brunt of parallel competition. This gives rise to new theories of construction, which are adopted to arouse fresh interest rather than to improve the truck, in the endeavor to divert attention from White *performance*.

At this late stage of motor truck experience there is no need of truck buyers being bewildered by fads and theories. Over and above the conflict of all theory looms the solid fact of White Truck performance—longer life, more days in service, lower eventual cost, as attested by comparative cost records of numerous large users and by the fact that such users purchase more White Trucks every year than trucks of any other make

THE WHITE COMPANY

CLEVELAND

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